JUL 1 1909

$4.00 per Year. JULY 1, 1909. Price 10 Cents.

PUBLIC LIBRARY OF THE CITY OF DETROIT

AMERICAN MACHINIST

A PRACTICAL JOURNAL OF MACHINE CONSTRUCTION.

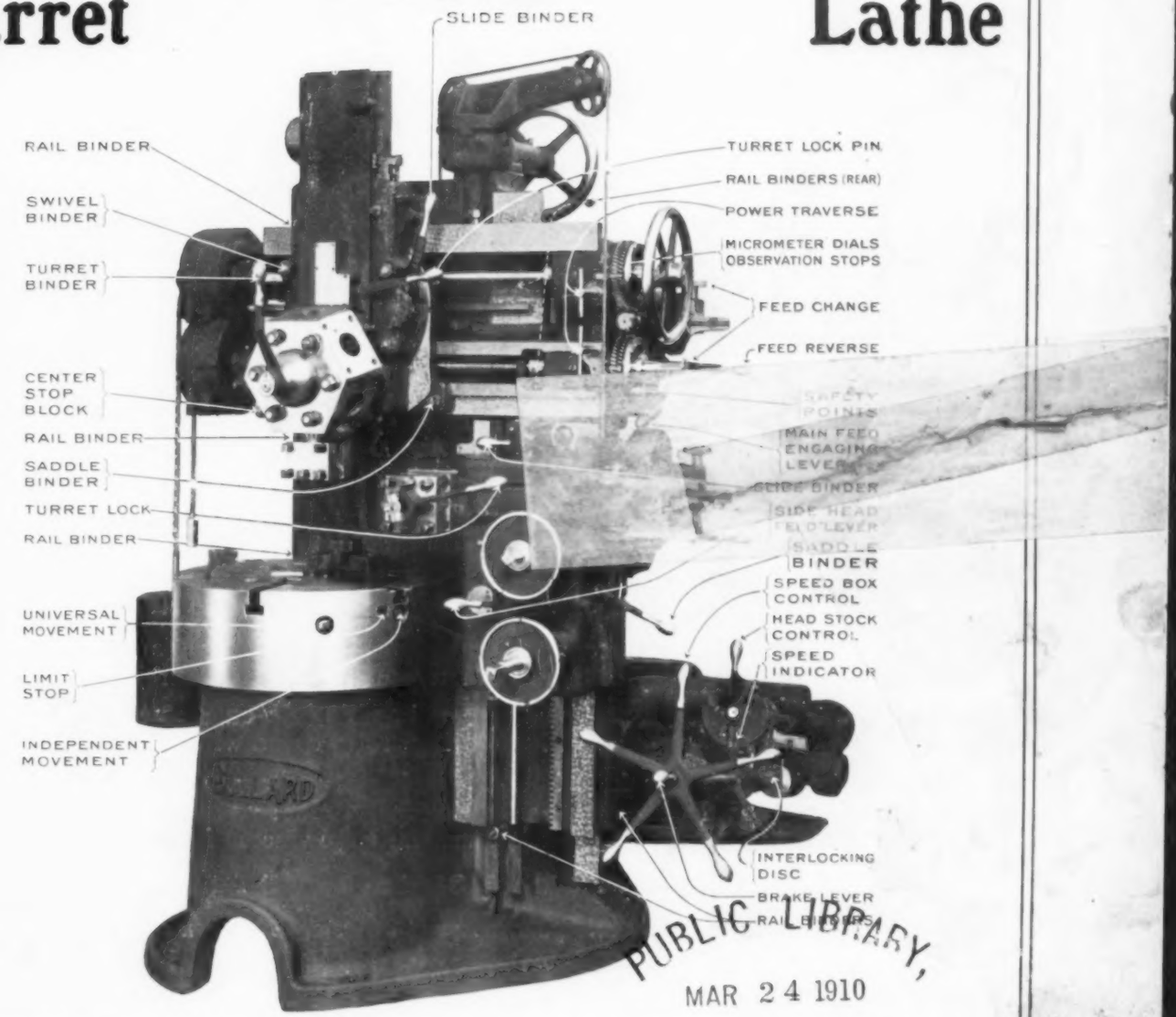
ISSUED WEEKLY BY THE HILL PUBLISHING COMPANY,

505 PEARL STREET, NEW YORK.

Vol. 32. No. 26.

Index to Advertisers and Classified Index Following Reading Matter.

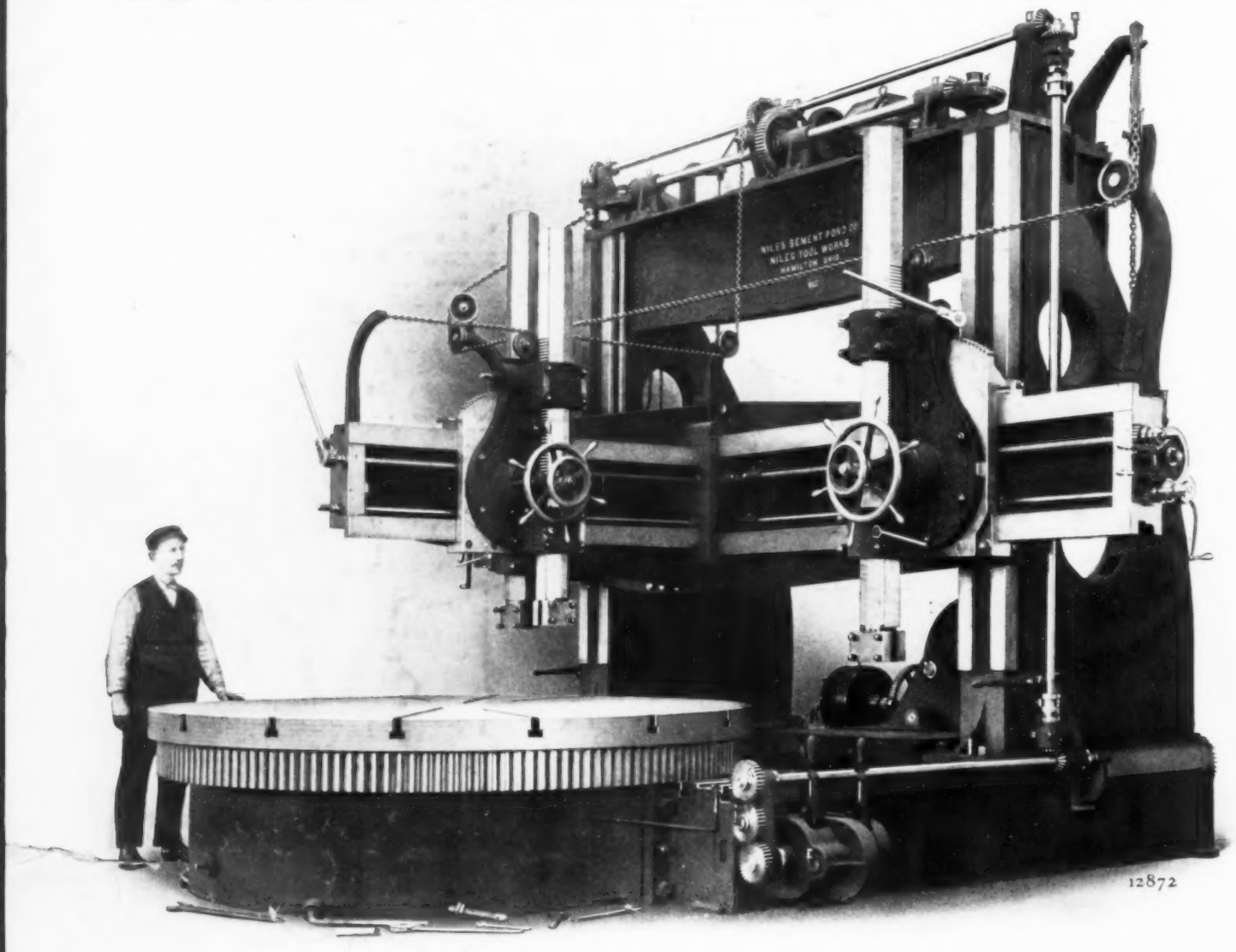
Study The Turret BULLARD Vertical Lathe



The boring mill and horizontal turret lathe work in your shop can be handled faster and more economically on the Vertical Turret Lathe. Write for treatise on face plate work, just published.

The Bullard Machine Tool Co., Bridgeport, Conn., U.S.A.

PUBLIC LIBRARY, MAR 24 1910 DETROIT, MICH.



10—16-ft. Niles Extension Boring and Turning Mill.

Rigidity depends upon the construction and proper distribution of metal.

Power depends upon accurately cut gears of the proper diameter and pitch and a driving pulley of large diameter and wide face or direct connected motor.

Convenience and ease of handling depends upon the levers and hand wheels being grouped and within handy reach.

These are the items that make the **N-B-P Boring and Turning Mills** capable of economic and rapid work. The extension feature on some sizes makes these mills particularly applicable to turning and boring occasional large pieces of work.

Twenty-five Sizes: 30 in. to 30 ft. swing.

Illustrated circulars and particulars of any size sent upon application.

NILES-BEMENT-POND COMPANY

111 Broadway, New York. **23-25 Victoria St., London, S. W.**

OFFICES:

Boston: Oliver Bldg. Chicago: Commercial National Bank Bldg. Pittsburg: Frick Bldg. St. Louis: 516 North 3d St. Philadelphia: 21st and Callowhill Sts. Birmingham, Ala.: Brown-Marx Bldg. Agents: The Canadian Fairbanks Co., Ltd., Montreal, St. John, Toronto, Winnipeg, Calgary and Vancouver. Agents for California, Nevada and Arizona: Harron, Rickard & McCone, 461 Market St., San Francisco, Cal., and 164-8 North Los Angeles St., Los Angeles, Cal. Ing. Ercole Vaghi, Milan, Italy. F. G. Kretschmer & Co., Frankfurt a.M., Germany. F. W. Horne, 70 C Yokohama, Japan.

(*See pages* 51, 52, 53, 54, 55, 56, 57 *and* 58)

620.5 v. 32 pt. 2
1226
8713a

Some Remarkable Printing Office Devices

Astonishingly Ingenious Mechanical Fingers and Thumbs so Sensitive to Touch as to Distinguish a Variation in Thickness of One Sheet of Paper

BY SNOWDEN B. REDFIELD

"New wrinkles" are of everyday occurrence, but not everybody who reads the AMERICAN MACHINIST knows that a real wrinkle, and automatically produced at that, plays a very important part in its printing. To the readers of the AMERICAN MACHINIST the devices which follow have a two-fold interest—that due to their intrinsic merit as exceptionally ingenious products of the machine shop and that due to the fact that they are part of the equipment of the paper's own printing plant.

The printing press is pointed to by historians as the first really great mechanical invention having a world-wide effect on the advancement of civilization. The original printing press, as is well known, was a very crude affair indeed, and since that time so many changes have been made in these machines, tending to improve their efficiency and to cause them to turn out better work at what would once have been considered incredible speed, that the modern printing machine bears but slight resemblance even to those presses in use as late as Franklin's time. These changes include the addition of a great number of automatic mechanical devices, which are quite remarkable in the manner in which they perform functions which were formerly performed by hand.

THE "WRINKLE"

Certain classes of presses make their impressions on separate sheets of paper instead of on long rolls as in ordinary daily newspaper work, and in order to feed in these separate sheets the automatic "wrinkling" device shown in Fig. 1 is used. There are two of these devices; that is, one at each end of the pile of

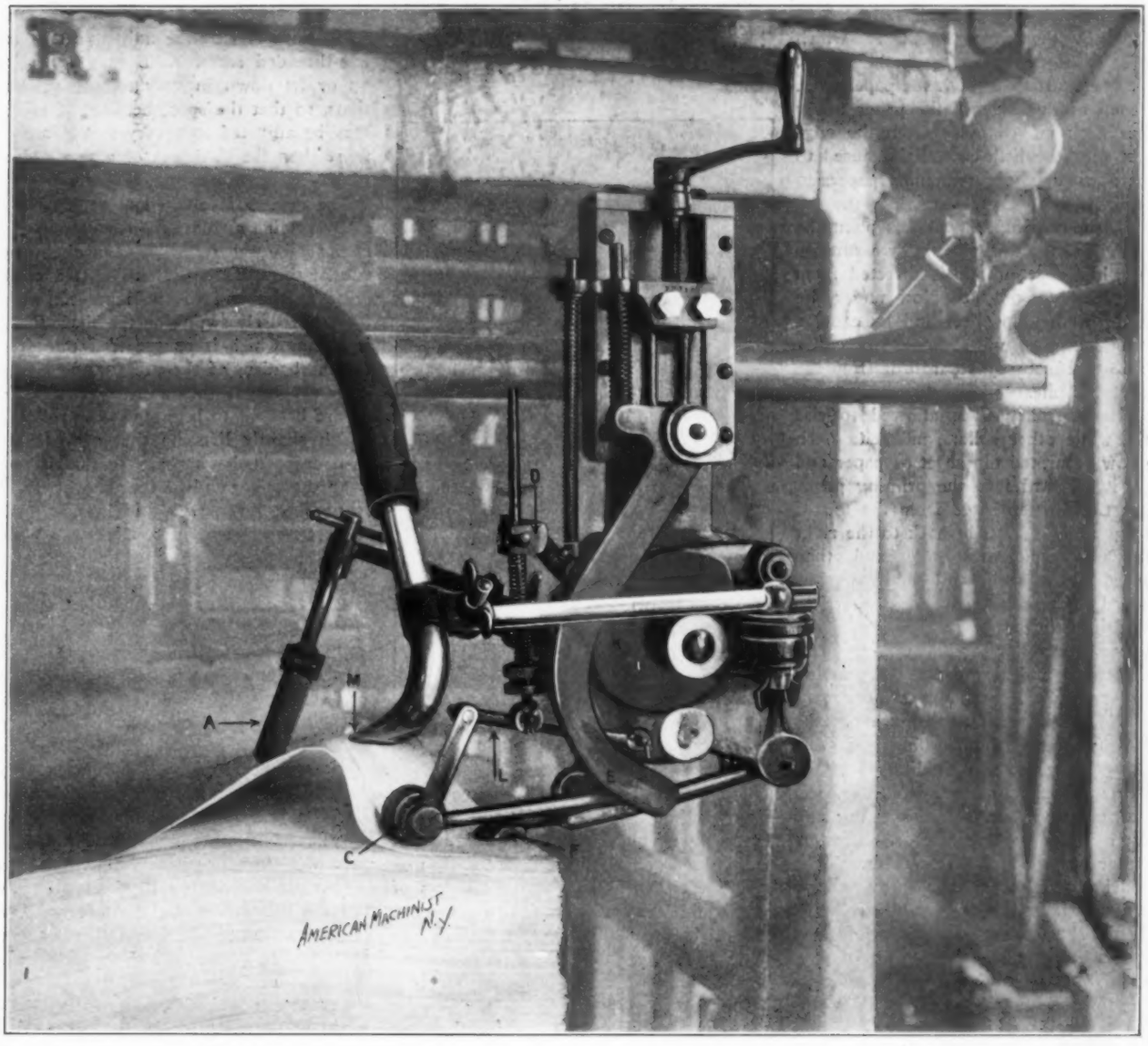


FIG. 1. THE AUTOMATIC FINGERS AND THUMB FEEDING THE SHEETS TO THE PRESS

papers, and by their operation one sheet of paper is lifted up and fed from the pile at a time.

In Fig. 1 the little roller *C* is made to bear down on the pile of papers, then to travel forward to the left by means of the bent lever *E*, which is in turn operated by the cam *K*. While traveling forward to the left, pressure is brought to bear upon the roller *C* by means of the arm *D* pressing down on the spring which connects with the arm *L* and the short link to the roller *C*. *D* is caused to drop and rise by means of a cam on the same shaft as *K*, but on the far side of it.

The motion of *C* in a horizontal direction, together with the pressure brought to bear upon it in a vertical direction, causes the top paper in the pile to wrinkle up, as shown in Fig. 1. This wrinkling is assisted by the rubber pencil *A*, which also bears down on the top of the papers, while *C* is starting to push the paper over. As soon as the edge of the paper under *C* has been moved away from the edge of the pile, the little arm *F* is caused to press down upon the remaining papers in the pile to keep these flat while the top one is being wrinkled. At this point the pencil *A* is caused to rise up by a suitable cam, while a jet of air is directed from the nozzle *M*, so as to blow under the wrinkle in the top sheet and by causing the top sheet to vibrate over its entire surface to effectually separate it from the rest of the pile.

Next the roller *C* is allowed to rise again, while other rollers and belts catch the now separated top sheet of paper and draw it forward into the printing press. When *C* has been lifted from the top of the papers, it is brought back to the right without touching the pile and then dropped down again and finally pushed forward to wrinkle up the next sheet, to be fed into the press.

These little rollers and arms keep pushing forward and lifting up and pressing down in a most remarkably human manner. So continuous and so much like the work of a set of human fingers is this pushing forward and wrinkling up of the top sheet of paper that one almost expects some fourth medium to come up and moisten the roller *C*, just as a manual operator would moisten his thumb at stated intervals to assist in the wrinkling up of the sheets. However, the roller *C* is better than the human thumb for its purpose, because being made out of rubber it does not need the intermittent moistening that the thumb usually calls for.

All the cams which operate these various parts are on one shaft, the end of which is seen in the photograph, and there is a separate cam for each lever. The small crank handle at the top is to adjust the whole feeding machine up and down, so as to bring the correct pressure on the top of the pile of papers, although as the feeding continues, the whole pile is automatically raised up at frequent intervals by feed screws operated from a motor in connection with a ratchet motion. This automatic raising is controlled by the pressure of a lever on the top of the pile of papers.

Mechanical Nerves

These little automatic wrinkling devices do their work very efficiently, but even as the human thumb would be liable sometimes to either miss a sheet altogether or pick up two sheets at a time, so these little automatic devices must be safeguarded by mechanical means taking the place of the intelligence of a manual feeder. The manual feeder would be able to tell whether or not he was feeding the sheets correctly by the feeling of the papers, and it is also by feeling, that is mechanical feeling, that assurance is given that one sheet, and only one sheet, is fed to the press at each proper instant. It

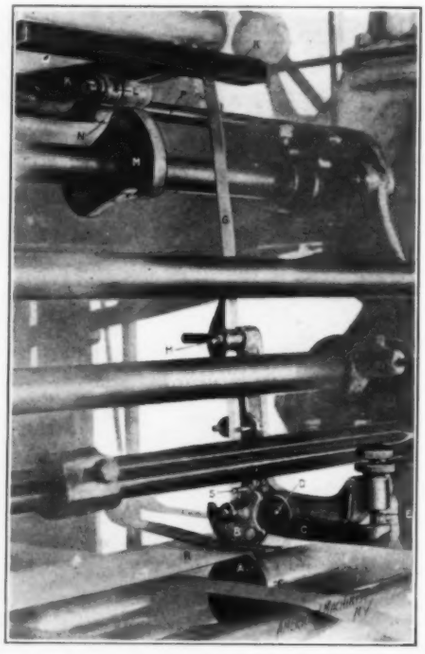


FIG. 2. AUTOMATIC TRIP FOR TWO SHEETS AT A TIME

may be thought that steel and iron and brass do not have much feeling, and it would be a difficult thing to use these materials for determining that the sheets of paper are being properly fed to the press, but, in spite of this, these materials are used to do the trick.

The first mechanical feeler encountered by the sheet of paper on its way to the press is the one which insures that not more than one sheet at a time is fed to the type. The principle upon which this device works is that two sheets of paper are twice as thick as one sheet. This sounds like a truism, but when one sheet of paper is so very thin, it would seem that two sheets of paper are not very much thicker. Notwithstanding this seemingly contradictory state of affairs, the device shown in Fig. 2 effectually counteracts such a blunder on the part of the set of mechanical fingers and thumbs shown in Fig. 1, and it is seldom that more than one thickness of paper will escape detection, resulting in immediate stoppage of the entire press until proper investigation, not to say explanation, is secured.

In order to understand the operation of the device shown in Fig. 2 the diagrammatic outline given in Fig. 3 may be studied. The sheet of paper is fed forward by the belts of the feeding mechanism, so that it has to pass through the small space between the roller *A* and the sectional roller *B*. *A* is caused to rotate mechanically to the right, that is in the direction of the travel of the sheet of paper *R*, while *B* normally remains stationary. *B* is centered on the lever *C*, which is also centered at *D* and by the adjustment of the fine-threaded screw *E*, *B* may be raised up or let down in very minute graduations, so that the space between *A* and *B* may be adjusted to a very small fraction more than the thickness of a single sheet of paper.

The arm *G* is pivoted at *H*, and normally retains an upright position, leaning against the set screw *J*. On the upper end of the upright *G* there rests a crosspiece at the end of the lever *K*, which lever is loosely swung on the shaft *P*. *M* is a cam which is caused to rotate from the mechanism of the press, and twice in each revolution the circular portions of *M* are brought to bear upon the roller *L*, which slightly lifts up the lever *K* and then drops it down again, so that it rests upon the upper end of the upright *G*. *N* is another lever which is keyed to the shaft *P*, and there is a slight space between the top of the outer end of *N* and the corresponding pad on the lever *K*, so that the two do not normally touch each other.

On the upper half of the sectional roller *B* there is a small pin *S*, which if *B* were caused to rotate about its own axis in a counterclockwise direction, would be brought to bear on the bottom end of the upright *G*. As long as a single sheet of paper is fed at a time between *A* and *B* there will not be brought to bear a sufficient friction on the circular surface of *B* to cause it to rotate, but when properly adjusted, if two sheets of paper are fed between *A* and *B* it forms what might be termed a friction drive, and *B* is caused to rotate in a counterclockwise direction pressing the pin *S* against the lower end of *G*. Of course, with the slight pressure caused by the extra thickness of paper only there is not very much force exerted; however, with the next half revolution of *M* the lever *K* will be caused to raise up about ¼ inch and this releases the upper end of *G*. When this upper end of *G* is released it takes but a very little side pressure on its lower end to overbalance *G*, causing its upper end to swing to the right and no longer act

as a support for K, when by the further rotation of M the roller L drops down into the depression in M. K being unsupported when L is dropped down into the depression in M, the whole lever will swing down by its own weight bringing pressure on the lever N, causing the shaft P to rotate.

The rotation of the shaft P causes the sliding of a latch, which disconnects the feeding mechanism of the press from its driving motor, and the feeding of paper instantly stops, while the straight side of the cam M comes up against the roller L, locking the parts in a stationary position. Further than this, the stopping of the feeding of the paper also stops the whole printing press by means of the next mechanical feeling device whose duty it is to stop the whole machine whenever the supply of papers runs short.

No Sheets, no Power

This next device is shown in Figs. 4 and 5, Fig. 4 being the sensitive or "feeling" end of the device. To understand the operation of this mechanism, a study of Fig. 6 is necessary, this being a diagrammatic arrangement of what is shown in the photographs. In the upper half of Fig. 6 we see the position of the parts just before the sheet of paper W strikes against the pendulum A. Before the paper strikes A the block D could not move to the right because if it did it would strike against the end of A; but when the sheet travels up against the bottom end of A, this little pendulum swings down, as shown in the lower half of Fig. 6. When in this position it is possible for D to swing over to the right without striking against anything.

Now D is caused to swing to the right by means of the lever K, which is clamped to the shaft E, and at the right of the diagram, Fig. 6, the mechanism at the other end of E is shown. Fig. 5 is a photograph of the other end of E. R is a cam block which is moved back and forth by the rod T, and as it moves to the left, Fig. 6, the roller P on the end of

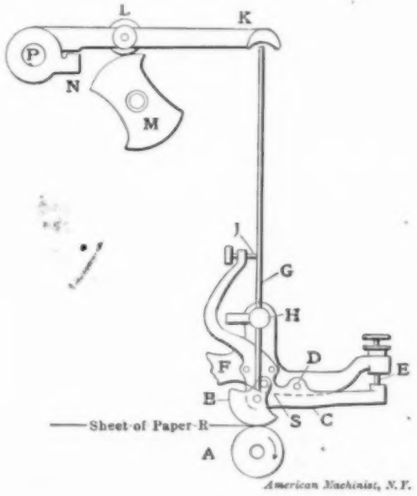


FIG. 3. DIAGRAM OF AUTOMATIC TRIP FOR TWO SHEETS

the arm keyed to the shaft E is allowed to drop down into the depression in R. This allows the shaft E to rotate by the gravity of the parts, swinging the arm K to the right and thus carrying D in the same direction.

The rod M leads to the switch of the electric motor driving the printing press, and on M is rigidly mounted the block L. On the cam block R and also moved by the rod T is the upright S. If the arm M remained horizontal, the upper end of S would strike against the block L, thus moving the rod M horizontally, throwing the switch and stopping the driving motor.

Under normal conditions when papers are being properly fed to the press the pendulum A swings down each time it is struck, as shown in the lower left-hand corner of Fig. 6. This allows E to turn by the dropping of P, as already described. However, the dropping of P has the effect of raising the other end of this arm N, and this lifts up the rod M and the block L is brought up above the upright S, so that they do not engage when S passes under L. In this way when everything is going right L is not pushed over by S and so the rod M simply rises and falls without any horizontal movement, and the motor is left undisturbed to continue the driving of the press.

If now a stoppage is caused in the feeding of the papers to the press, the pendulum A is not tipped down, and when the cam R moves to the left (Fig. 6) the roller P cannot drop into the depression in R because D would strike against the end of A when E attempted to rotate. As P cannot swing down, N cannot swing up, and consequently the rod M and its block L remain in their horizontal position; S engages with L, moving M and stopping the motor, and consequently the whole press. In this way two automatic checks are placed upon the feeding fingers, and no matter what goes wrong the printing press will stop until the troubles are corrected.

It should be said that when the papers are being fed properly to the press and are striking against the pendulum A, while K and D are swinging to the right, the paper rests against A for an instant. Immediately after K and D have swung back to the left by the next movement of R to the right, the shaft C is caused to rotate

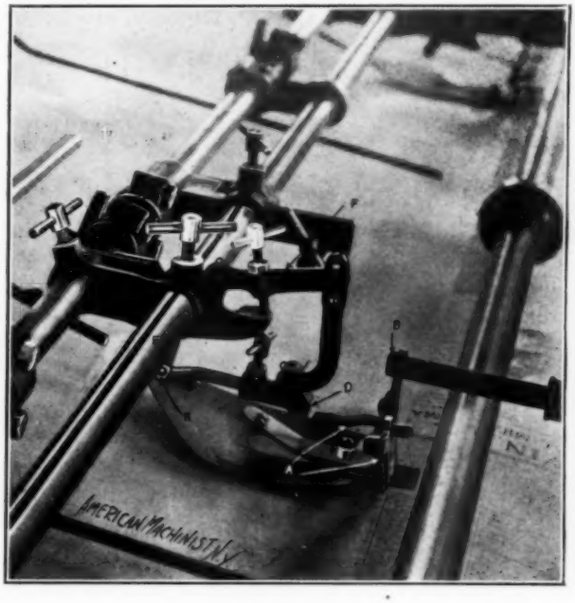


FIG. 4. AUTOMATIC TRIP FOR NO FEED

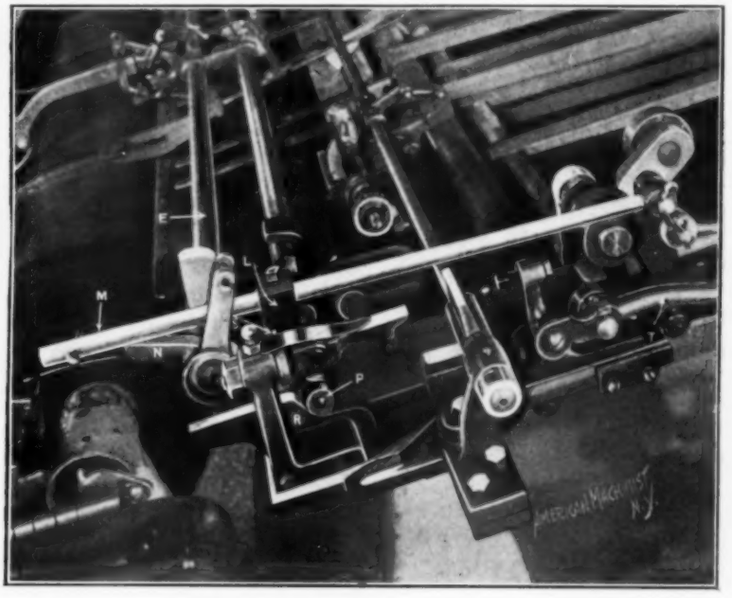


FIG. 5. MOTOR CUTOUT FOR NO FEED

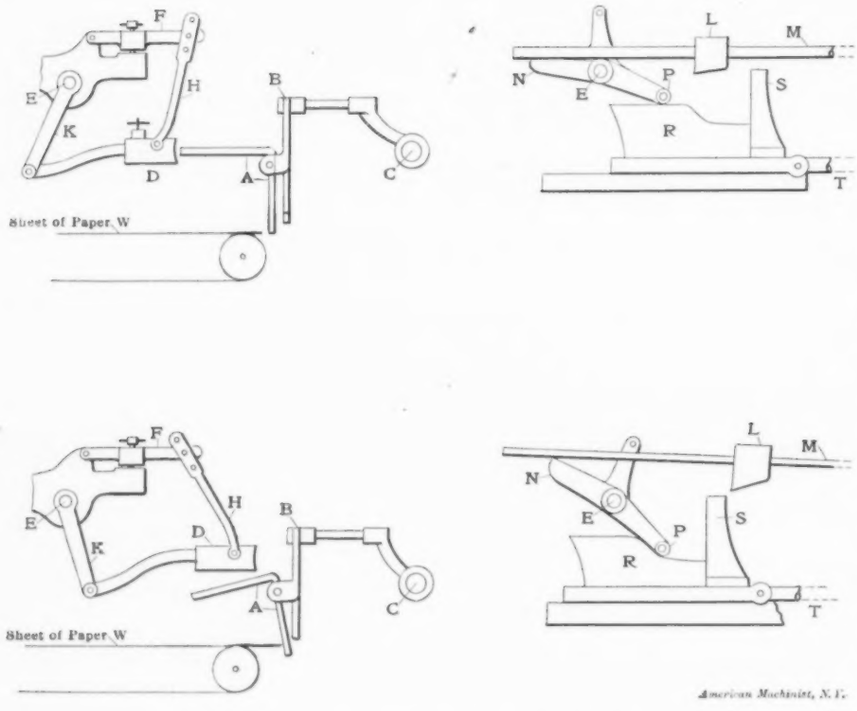


FIG. 6. DIAGRAM OF AUTOMATIC TRIP FOR NO FEED

in a clockwise direction, lifting the bracket *B*, the pendulum *A* and allowing the paper *W* on the belts to pass to the right into the press. The extra lever *F* with its small thumb screw is simply for adjustment of the elevation of the block *D*.

A Hydra-headed Machine

Another very ingenious printing-office device is a machine having 22 mouths, used for assembling together the various pages of the American Machinist and for stitching them into place. Figs. 7 and 8 are partial views of one of these assembling machines, and on the far side may be seen the piles of paper *V*, in Fig. 8. Each one of these piles is composed of duplicate sets of pages, each set composed of 16 pages folded from one sheet by the folding machines. The first pile would then contain duplicates of pages 1 to 16 of the magazine inclusive, and the second pile would contain pages 17 to 32, inclusive, and so on down the line making the complete magazine. By feeding in a set of folded pages from the first pile, and then dropping on top of this a set from the second pile, then from the third, fourth, fifth, etc., the piles being arranged in correct consecutive order, the complete magazine is built up with all its pages in proper sequence.

In Fig. 8, *W* is a pair of rubber noz-

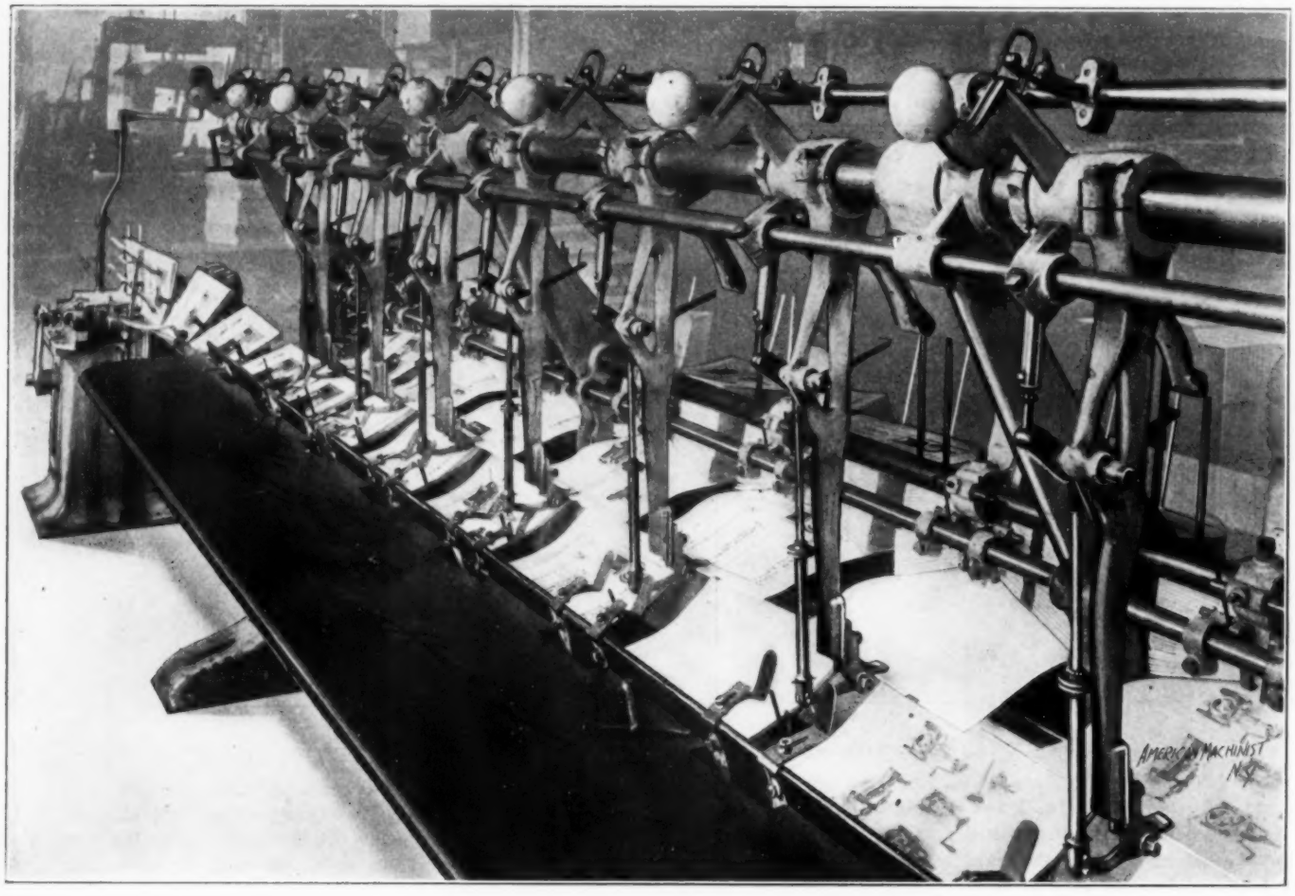


FIG. 7. PART OF THE AUTOMATIC MACHINE THAT ASSEMBLES AND STITCHES THE AMERICAN MACHINIST

zles leading from an exhaust system, and the block holding these nozzles is caused to rise and fall by the turning of the shaft X upon which it is mounted, by a suitable cam motion. The piles of paper V rest upon iron saddles with a cut-out section just over the nozzles. The fingers T are caused to draw away from the pile V at the proper moment by the rotation of shaft Z and the nozzles are brought to bear on the under side of the pile of papers. The air suction is applied through the nozzles, causing the bottom sheet of paper in each pile to stick to the ends of the nozzles, and as these nozzles are brought down by the cam motion, the bottom sheet of paper is bent down and pulled away from the whole pile, while at the same time the fingers T again come back into contact with the pile in order to hold the other papers up into the proper position.

As the bottom sheet is pulled down, the arm H is caused to swing on the shaft M, and by means of the various arms and links controlled by the shaft G, operated by suitable cam motions, the mouth A is caused to open and then to close over the bottom sheet of paper held by the suction clip, and by the next back swing of H the bottom set of sheets of paper is drawn out from under the pile and dropped down into the conveyer Y. Fig. 7 shows the sheets just coming away from the piles. The arm H advances again, the mouth A swings forward and pulls out the next bottom sheet which is being drawn down by the suction nozzles, thus continually pulling out and dropping down the bottom sheets from the piles, one set of sheets at a time.

The conveyer Y traverses this whole set of bottom sheets, one from each pile, in a transverse direction, and as each set of sheets is brought opposite a pile, the arm opposite this pile drops the next consecutive bottom sheet upon it, so that by the time the first sheet has reached the end of the machine it has had dropped upon it all the succeeding sheets going to make up the magazine, each in its proper consecutive order.

When all the pages have thus been assembled they are passed through the stitching machine, shown at the end of the line, Fig. 7, where two wire staples are forced through the sheets cut off and bent over, binding the whole magazine into one piece. After this, of course, the bound sheets have to be trimmed and covered to make the finished magazine.

A Sensitive Mouth

It is easy to imagine that with such a device as this it might be perfectly possible for one of the mouths to miss its grip on one or more of the sheets of paper and not feed them in proper order. Also it might be perfectly possible for two sheets to be gripped at once, thus again spoiling the consecutive action. In order to guard against this the lever D, Fig. 8, is extended upward, and has upon its outer end a small hook, as shown in the figure. With the swinging back and forth of the arm H, and the opening and closing of the mouth A, this outer end of D describes an oval figure, passing upward and outward, then dropping down on the far side of the extension K, then drawing back between two metal projections which are fastened onto the arm K.

This figure described by the hook is a highly magnified reproduction of the travel of the end of the mouth A, and, of

FIG. 8. DETAIL OF ASSEMBLING MACHINE

course, greatly distorted by the various lengths of the levers. The opening of the mouth A is very greatly exaggerated in the position of the end of D, and if A fails to grasp the bottom sheet from the pile of papers, the end of D would be allowed to drop much farther than usual and would strike against the projection on the side of the arm K. The hook on the end of D would then draw K downward, which would cause the arm carrying the ball N to swing upward. This in turn would lift the end of the lever P, causing the shaft R to rotate, which in turn immediately operates a belt shifter to stop the whole machine. Also in case A should grip two papers instead of one the arm D would not be allowed to drop down as far as usual, and it would be caused to strike against the upper projection on the side of the arm K, again drawing K downward, lifting the arm carrying N and again rotating the shaft R to shift the belt and stop the machine.

This gaging device seems rather crude, but, as a matter of fact, it is not, for it can be so accurately adjusted that the difference of one sheet of tissue paper will cause the hook on the end of D to strike against the projections on K and instantly stop the machine. The accurate adjustments are made by means of the thumb nut on the link C. F is a spring in the link, provided for the purpose of making the motion of G independent of the limiting adjustments of the thumb screw C, and consequently the opening of the mouth A, although the stiffness of the spring F is such that A must be positively opened and closed by the motion of G.

Projecting through the bottom of the conveyer and separating the piles of pages there is a series of upright pins B, Fig. 8. These pins are fastened to chain belts which travel side by side. One of these belts travels at a constant speed, whereas the other one travels first at the same speed as its mate, and then is caused to lag behind until it is separated from the other one by a distance of about 3 inches. Next it catches up with its mate and travels along for a short distance side by side with it. This oscillating motion causes the spaces between the pins to alternately decrease and increase. The increase in the spaces takes place at the time when the various arms are dropping the sheets of paper down onto the conveyer and immediately after this has taken place, the space is again decreased by the lagging of the pin. This draws together all of the papers in each pile so that their edges coincide, instead of being thrown in in irregular heaps.

There are 22 of the arms and mouths, and saddles for 22 piles of papers, and when each pile is composed of folded sheets making 16 pages, this machine is capable of automatically assembling a magazine having 352 pages. Of course, by the addition of more arms and saddles the machine could be made long enough to handle an indefinite number of pages.

Book Sewing

Fig. 9 is a view of a book-sewing machine, for novels, text books, etc., in the binding department of the Butler-Ward Company, of New York City. The folded sheets composing 16 pages are laid over the four revolving arms A in the figure, carried around, lifted up and placed beside the other leaves to which they are to be sewed, at B, while from above, C, four or more curved sewing-machine needles are thrust through the paper. First, a sliding connection at the top of E grips a bar D, inside of the carriers A when the

leaves are in place at *B* and the operation of a cam moving this bar thrusts a series of pointed pins from inside of *A* through the folded sheets at the fold, making openings for the needles to pass through. This insures that the needles shall go through the center of the sheets just where they are folded, and there is no danger of not sewing through the full number of sheets.

The needles themselves are curved into practically a semi-circle, and they pass through the sheets of paper twice; that is, once from the outside in and then from the inside out. The sewing is of the single-thread character and there are the usual small moving fingers and hooks and points at *C* for looping up the threads holding them while the next loop is passed through, forming a chain stitch along the back of the book. The number of lines of stitching depends upon the size of the book. In operation a great many books are continuously sewed together, but the operator who carries away the product of the machine cuts the various books apart at the beginning and ending of each.

FIG. 9. BOOK SEWING MACHINE

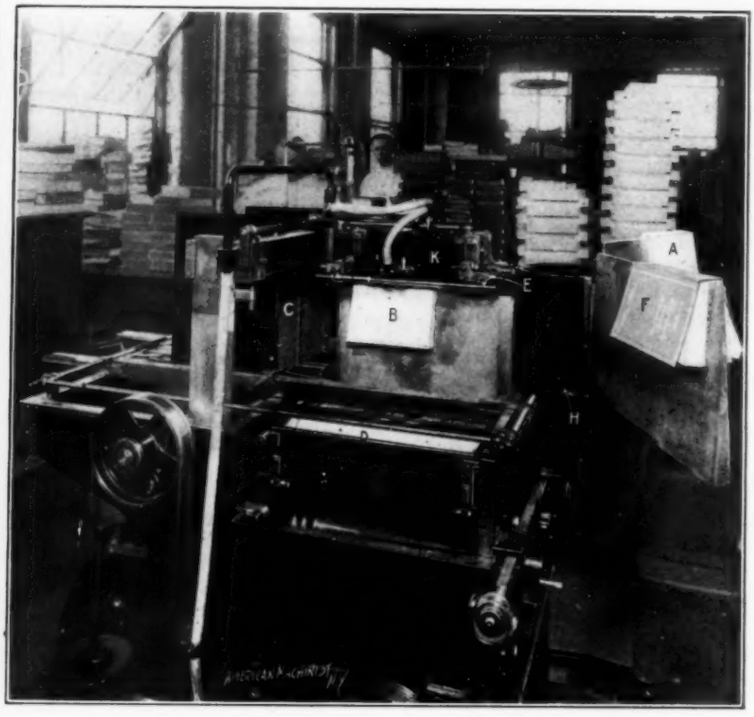


FIG. 10. BOOK COVERING MACHINE

Automatic Book Covering

Fig. 10 shows a machine that is doing work which up to a very recent date has always been done by hand; that is, the gluing on of the covers of bound books. On this machine, which is also used by the Butler-Ward Company, there are three swinging arms, and as seen in the picture, an operator places the sewed but still uncovered books, one at a time on the arm nearest to him as at *A*. The next motion of the machine carries this book around under the overhanging, sliding head *K*, as at *B*. The three swinging arms are mounted on their central spindle in vertical sliding grooves, and they are held at an equal level by a stationary horizontal groove *H*, around the bottom of the central spindle, meshing with a finger at the bottom of each arm.

When an arm is brought under the sliding head of the machine, that is in position marked *B*, the finger at the bottom of the arm is opposite an opening in the bottom of the groove, and by a cam motion another finger rises up from underneath the machine and grips the swinging arm at the spindle end. The next motion pulls this arm down into the machine, and the photograph shows one of the arms part way down at *B*. Its downward motion is followed but not touched, by the overhead part *K* and when it has reached the bottom of its travel, an automatic cross slide pulls in one of the covers, which are arranged in a pile in the hopper at the left as shown in the photograph at *C*. While the arm is descending and carrying down the uncovered book, a jet of air is directed against each side of the book to hold the pages down against themselves where they belong, and to prevent their flying up, due to the sudden downward motion of the arm carrying the book.

After having reached the lowest position, another cam motion draws two boxes of paste *D*, up against the sides of the uncovered book, the paste being distributed by means of corrugated rollers on the sides of the paste boxes, and the next motion lifts up the book as it passes between the paste rollers, smearing the entire surface of each outside leaf with the paste, and at the same time lifting up the cover which was placed over the back of the book. As the book and cover come up both are gripped by two steel plates in *K* near the upper edge where there is a groove in the binding of every book, and this gripping squeezes the covers against the book at this point. As the book rises the sides of the cover naturally fall down like the wings of a bird, and they are pressed against the sides of the book by means of two swinging arms, one of which is shown at *E*.

When the now covered book has been raised to normal hight, the overhead part *K* rises still further, the grip, of course, having released, and next the swinging arms make another 120-degree turn, passing out the now finished book to one side of the machine. Here it is met by a pair of fingers which grip it and carry it forward to the left, as shown in the photograph at *F*, and carrying in a new one to be covered. After this, in order to be sure that the covers are tightly pasted to the book, they are piled under presses and heavily squeezed together to make a good job.

Various adjustments in the lengths of the rods and the relative positions of the parts of the moving mechanism make it possible to cover books in a very considerable range of sizes.

Nearly $5,000,000 worth of American automobiles were sent in 1908 to 50 countries and colonies, including, first, the United Kingdom, $1,500,000 worth; Canada, $750,000; France, over $500,000; Mexico, $333,000; Italy, $250,000, and Cuba, $167,000.

Automobile Cylinder and Piston Finishing

By Hugh Dolnar

Notwithstanding the great number of small gas-engine car motors now being produced in the United States there is as yet no settled and fixed practice as to cylinder boring and cylinder-bore finishing, nor to piston form and finishing, nor to piston-packing construction. The gas engine in the form used for car motors is an American invention, patented here in 1844 and 1846, exploited by Lenoir in Paris as an original French invention a whole generation later, and finally "perfected" by changing from the two-stroke cycle to the four-stroke cycle as reasoned out by another Frenchman, Beau de Rochas, and worked out in practice by a German, Daimler, under the patronage of another German, Dr. Otto. The earliest gas-engine driven American cars endeavored to use the two-cycle motor, crank-box cylinder supply, but soon turned to the Daimler motor, which came to us loaded with traditions of European machine-shop practice, and is even now in transition to less costly and uncertain forms of valves and valve actions, while the four-cycle of Beau de Rochas is challenged by the original American conception of the two-stroke cycle. Reverting to cylinder boring and cylinder-bore finishing, some makers advocate boring first and finishing by reaming, while others finish the rough cylinder bores by grinding, and yet others finish them by a true lapping with lead laps, or by a "running in," in which the crank shaft, rods, pistons and cylinders are assembled and the crank shaft is belt-driven to reciprocate the pistons in the cylinders with water and oil, or oil and some abrasive for lubrication; this last operation is also often mentioned as "lapping."

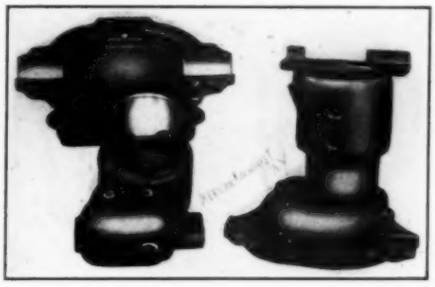


FIG. 2. CARTERCAR OPPOSED MOTOR CYLINDERS, PART OF CRANK-BOX, INTEGRAL WITH EACH CYLINDER

Advocates of cylinder-bore finishing by reaming only, point to the undesirable fact that the complicated forms of water-jacketed cylinders, often in dual units and sometimes in quadruple units, cause the cylinder-bore form to change when the cylinder is heated, and hence assert that cold cylinder grinding is labor thrown away, because the cylinders are hot when working and must finally have the working form of the cylinder bore determined by the wearing down of the high spots by piston travel over them.

Advocates of finishing by grinding assert that heat does not materially distort the cylindrical bore of the cold cylinder, and that the cylinder can be finished more quickly, at less cost and with better results by grinding than by reaming, while advocates of lapping and "running in" point to the fact that ground cylinder bores show markings from piston travel, and that piston travel with lubricant and an abrasive is the only reasonable and logical final cylinder-bore finishing practice.

The piston head is much hotter than the open end of the trunk form of gas engine while working, and this fact of greater increase of piston-head diameter when working leads to giving the piston body many different exterior forms.

The Cartercar Cylinder and Piston Finishing

The Cartercar Company, Pontiac, Mich., will put out about 1000 cars in the season of 1909, with two forms of motor, one four-cylinder and one two cylinders opposed. This Cartercar two-cylinders-opposed motor is a new design, shown in Fig. 1 (construction drawing reproduction), which is valuable in itself as show-

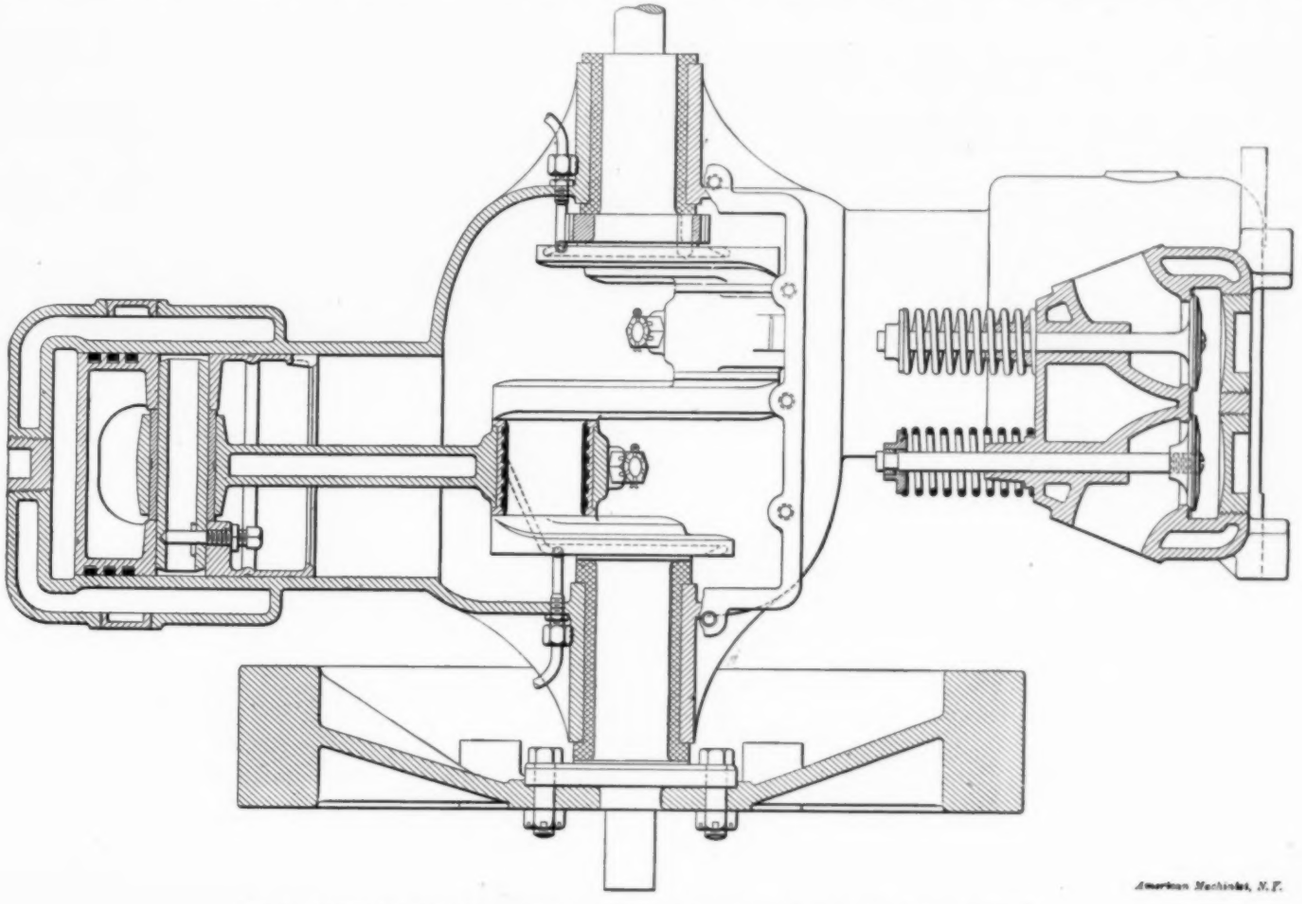


FIG. 1. CARTERCAR OPPOSED-CYLINDER MOTOR, CONSTRUCTION DRAWING REPRODUCTION

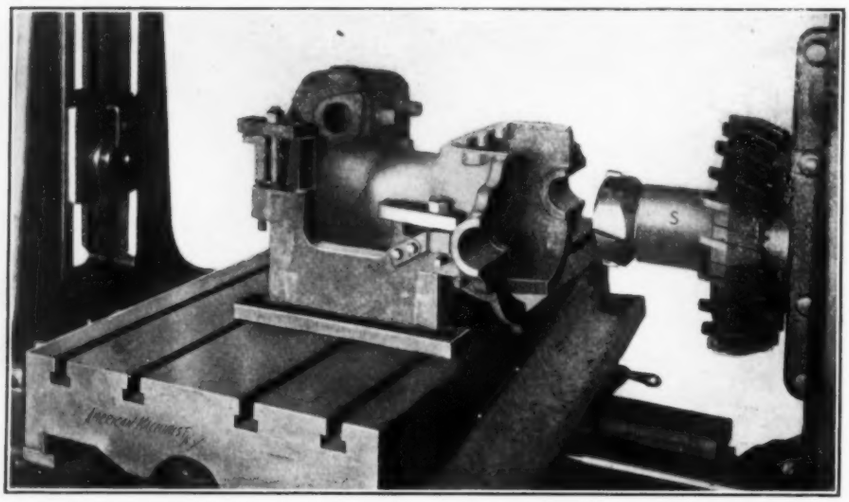


FIG. 3. CARTERCAR CYLINDER FINISHING

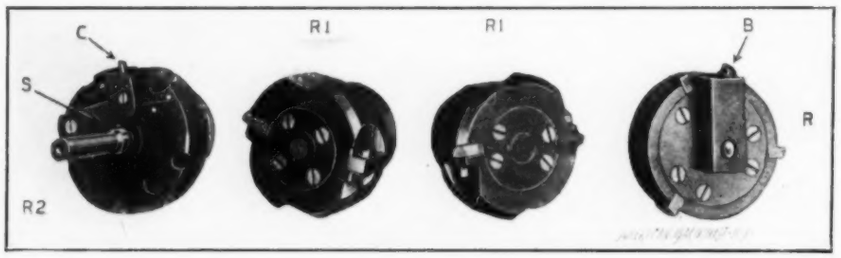


FIG. 4. CARTERCAR CYLINDER BORING HEADS

ing one of the latest forms of the opposed cylinders, four-cycle motor, which continues to be largely used for motor-car driving. The Cartercar practice in finishing the cylinders and pistons of this two-cylinder motor is here illustrated and described. The cylinder bore is 5½ inches, the piston stroke is 4½ inches, and the

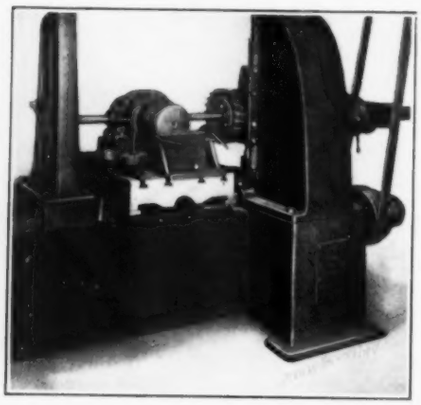


FIG. 5. CARTERCAR CYLINDER FINISHING

motor is rated at 24 horsepower. The cars are friction-driven with a single, cased-in chain to the rear axle. Fig. 1 will be readily understood. No dimensions are given. The flywheel is 19¼ inches diameter by 3½ inches face.

The crank box is divided in the middle, part being integral with each cylinder, as shown in Fig. 2. This construction of cylinders and crank box makes it desirable to bore the cylinders and face the crank-box joining at one setting in the Lucas horizontal boring mill on which these cylinders are bored and faced, and materially affects the cylinder-finishing scheme.

Fig. 3 shows one of these cylinders in the boring-mill fixture, bolted to the boring-mill table. The boring spindle carries an inserted-tooth face mill, of sufficient

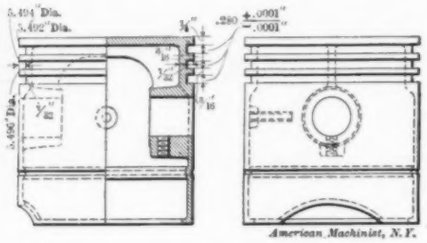


FIG. 7. CARTERCAR PISTON WORKING BLUEPRINT REPRODUCTION

diameter to cover the crank box facing cut. A sleeve *S* is slipped on the boring spindle outside of the facing mill, and the cylinder boring heads shown in Fig. 4 have threaded shanks and are screwed hard against the sleeve. The sleeve *S* is used for cylinder-bore cuts only, and is removed for crank-box facing, so that the table can be traversed, as will be readily understood. The cylinder heads are closed so that there can be no rear support for the boring spindle.

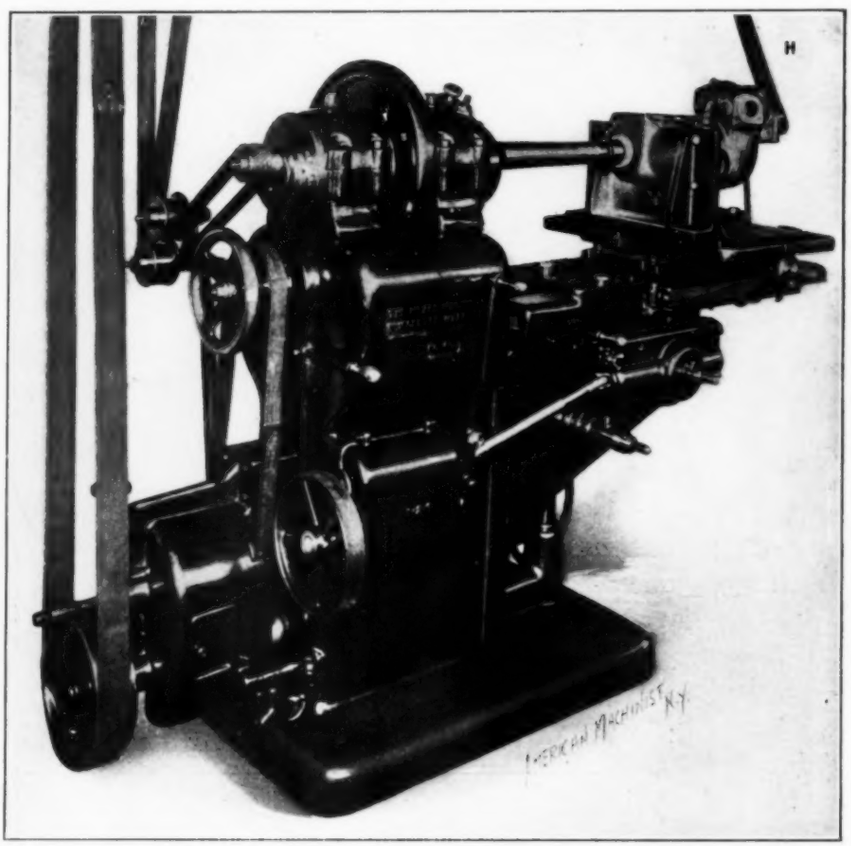


FIG. 6. CARTERCAR CYLINDER GRINDING ON HEALD GRINDER

Four cutter heads are used for the cylinder boring, shown in Fig. 4, marked *R1*, *R1*, *R* and *R2*. Of these *R2* carries a swinging stock *S* which cuts the bore to a fixed length at the compression-chamber end from the crank-box joining face. Heads *R1* *R1* are duplicate roughing heads, two cutters in each; two heads are used so that the boring-mill hand can grind the cutters of one while the other is working. Head *R* is the three-cutter cylinder-bore reaming head. At *B* is an angular cutter attached to the boring head *R*, and used to cut the ring-entering chamfer at the open end of the cylinder bore; *R2* is for finishing the inside end of the cylinder bore and has a swinging arm with the small cutter *C* fixed in the outer free end. The inner free end of this swinging cutter stock *S* rests on a sliding rod having two diameters connected by a conical surface. This sliding rod is stopped at its rear end by a stop moving the boring-mill table. After the cylinder is reamed the head *R2* is screwed on the spindle nose and the table is run toward the boring spindle so that the incline on the sliding rod forces the cutter *C* outward to determine the inside end of the cylinder bore at a fixed distance from the crank-box joining face.

Fig. 5 shows crank-shaft box-seat boring, after the opposed-cylinders crank-box faces have been bolted together on the same Lucas boring mill.

The cylinder grinding is shown in Fig. 6, on a Heald machine. The cylinder is stationary and the cylinder bore is sucked by a fan through the hose *H*, which carries away the dust of grinding and cools the cylinder during the process

FIG. 8. CARTERCAR PISTON GRINDING ON A LARGE LANDIS GRINDING MACHINE WITH A LARGE GRINDING WHEEL

of grinding. The grinding-wheel spindle is eccentrically positioned in a parallel axis revolving head spindle to give a constant cylinder-bore diameter as the grinding wheel wears down.

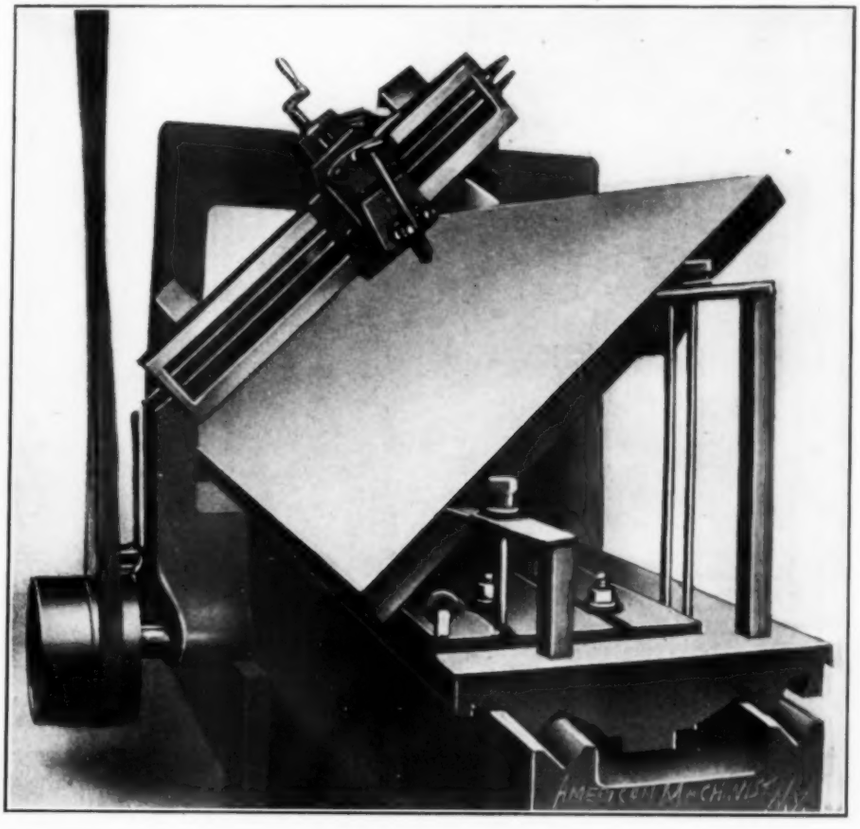
Fig. 7 is a reproduction of the piston-working blueprint with a few dimensions. The pistons are turned on small engine lathes, pin holes bored, the ring grooves are cut on small engine lathes, a rough grooving gang of three cutters in one lathe and finish-grooving gang of three cutters in another lathe. The piston grinding is done on a heavy Landis grinding machine, as shown in Fig. 8. The grinding wheel is large and is flooded with water.

The time details of the cylinder and piston finishing are as follows: The cylinder bore is 5½ inches diameter by 9 inches long, two cuts through, first cut with two-point cutters, second, reaming, cut with three-point cutters. The large crank-box face mill runs 60 feet per minute. The cylinder bores have four cuts, one boring cut, one reaming cut, one chamfer cut and one inside compression chamber cut. The average time for cylinder finishing on the boring mill is 66 minutes, of which 25 minutes is consumed in two crank-box facing-mill cuts, leaving 41 minutes for the four cylinder-boring cuts. The cylinder-grinding time averages 60 minutes. The finished bore is within half a thousandth of size. The piston turning, two cuts, takes 15 minutes. The piston grinding, three diameters, takes 6 minutes for each piston.

A Large Job on a Small Planer

By Warren S. Sherman*

The casting shown on the planer is a gate valve of gray iron, 6 feet long and ranging from 30 to 40 inches wide and weighing from 1000 to 4500 pounds. Our first thought was that possibly we could widen the machine by putting parallels in between the housings and bed of the machine, but still we didn't have enough room to accommodate the work. I finally arrived at the conclusion that planing them on an angle was the only solution. I made a rest to receive the lower corner of the casting (as shown in the cut at the lower left-hand corner) out of 2½x1-inch iron and bolted one to receive each end of the piece to be planed. I took off the cross rail, turned it bottom side up, to avoid having the lugs that rest on the housings in the way, and swung the head around, bottom side up also. This necessitated making a clamp to clamp the two ends of the rail to the housings and also a great deal of worry as to a feed of some kind. When the rail had been clamped in place the casting was set on the planer parallel with the rail by means of special jacks made to accommodate the casting at the angle shown without slipping. After being securely clamped it was ready to start, but the idea of having to feed by hand over so much surface didn't look good to me, so we arranged a ratchet feed by means of a rope and pulley attached to the roof, one end of the rope attached to the feed mechanism, and the other to the ratchet.



A LARGE JOB ON A SMALL PLANER

We had 42 of these pieces to machine, and in this way we did them all on a 26-inch by 8-foot New Haven planer. When put in place they were all true and tight under a head of 60 feet of water.

*Superintendent, N. S. Sherman Machinery and Iron Works, Oklahoma City, Okla.

Engineering in the Eighteenth Century

Interesting Facts about Steam Engineering Practice One Hundred and Fifty Years Ago, with Illustrations of the Quaint Engines Used

BY EDWARD P. BUFFET

The best cure for pessimism is to take a look back one or two centuries into the days of rack and thumbscrew. The best answer to the man who claims that this is not an enlightened age, mechanically, is to tell him something about the century before last. Just why steam engineering so long remained crude and undeveloped may be open to differences of opinion, though the prevailing view seems to be that it was because mankind was awaiting the appearance of the AMERICAN MACHINIST.

Records of eighteenth-century engineering are scarce, chiefly for the reason that there was then so little to record, but also because comparatively little of what then was done became embalmed in print. Specialized practical mechanical journals were, of course, unheard of. When an inventor was smitten with an uncontrollable attack of "itch for scribbling" he relieved himself either by writing a letter to the newspapers or else by seeking the patronage of some noble and "easy" lord for the wherewithal to confide his lucubrations to the public in pamphlet form.

For this reason it is a happy discovery when we unearth the files of any old periodical treating even occasionally upon engineering subjects. Probably not many readers of the AMERICAN MACHINIST have ever perused *The Universal Magazine of Knowledge and Pleasure*, a sixpenny monthly which was published in London, by J. Hinton, and lasted from 1747 to 1803, or longer. Many of its numbers contain descriptions, with copper-plate illustrations, of machinery used in its day, and these articles, although intended for popular reading, are presented technically enough to be instructive for the engineer. A set of the magazine constitutes, therefore, a most informing history of engineering progress in the eighteenth century. It is from skimming such a file that I propose here to serve up the cream.

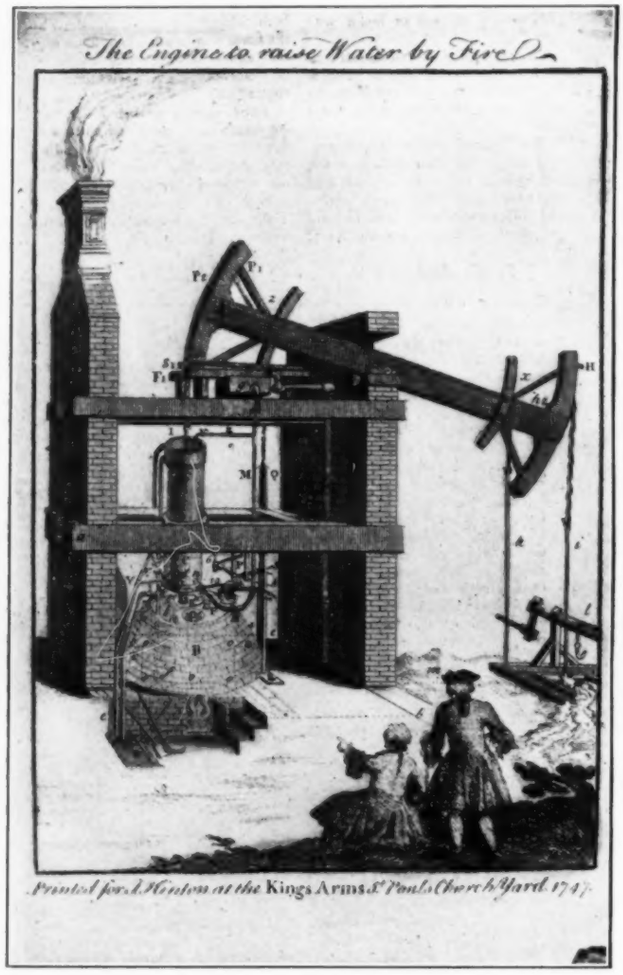


PLATE 1. THE NEWCOMEN ENGINE

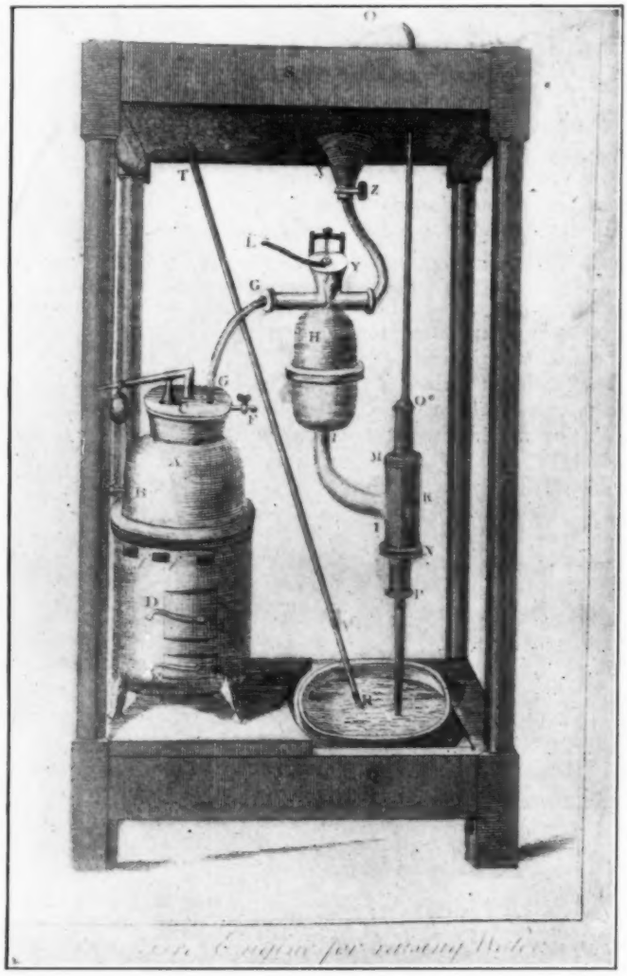


PLATE 2. THE SAVERY ENGINE

THE NEWCOMEN ENGINE

In the very first volume of the magazine we find an elaborate description of "The Engine to raise Water by Fire"—in short, a Newcomen steam engine (Plate 1). Its writer may tell the tale in his own language:

"To the Authors of *The Universal Magazine*, Gentlemen:

"I have observed in the Circle of my Conversation that it appears very mys

terious to those who are not learned in Hydraulics, how a Town or a House can be supplied with Water from a River, or Spring, that is in a Situation much below the Place into which it runs; when it is very certain that Water is of that heavy Nature as always to descend, when left to its own Course. Therefore I have sent you inclosed a Draught and Description of an Engine invented for this Purpose. And, though there are many other Sorts, I have rather selected this particular Engine because it is the most admirable, curious and compounded Machine amongst all those Inventions which have been owing to modern Philosophy, and affords the greatest Advantages to Mankind; as could be exemplified from the Water works near Chelsea, on the West of this great City, and again by those lately erected near Stratford in Essex, on the East of London, which are able to supply the adjacent Country, several Miles in circumference, with the necessary Provision of good and wholesome Water, at

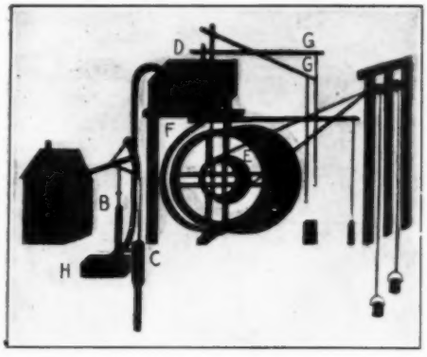


PLATE 3. WORKING MINE WITH NEWCOMEN ENGINE

a moderate Charge, which before was wanting, both for household Service and in the Danger and Loss by Fires. To this I could add the Impossibility of working several Collieries without its Assistance, as the Proprietors of Elsick, Heaton, Biker &c. near Newcastle upon Tyne, can bear me witness. This Engine also is improveable for many other great and valuable Uses, as the Reader will be able to judge, when he has well considered what follows.

"About the year 1663 the Marquis of Worcester, having proposed, in print, the raising of great quantities of water by the *force of fire, or by turning water into steam*, mentioned an engine of that kind, at that very time in being, which could raise a continual stream, like a fountain, 40 feet high, by the means of two cocks, which alternately and successively were turned by a man to empty the hot, and to force and refil the vessel or cylinder with cold water, the fire being continually kept up; I must adjudge this invention to that noble Lord, tho' it must with justice be confessed that it has received many improvements since his time.

"This invention, great as it was, lay dormant, till Capt. Savery, treasurer to the sick and wounded office, having read the Marquis's book, took the hint, and pretended to find out the secret of nature by such a chance as upon experiment is found could not give any such idea; and to secure the credit thereof to himself, he bought up, and burnt all the Marquis's books he could find. Thus Capt. Savery claimed the credit of this machine to himself, and obtained a patent for the sole erecting thereof, as I have been told."

Our writer informs us that the captain made a good many experiments to bring this machine to perfection and that he erected several with good success on gentlemen's estates, but "he could never bring it to bear for working of coal pits or mines, or to supply towns with water, where the water was to be raised high and in great quantities; because such a work required a steam too dangerously strong to be attempted in his way.

"These discouragements had certainly sunk this necessary machine into oblivion had not Mr. Newcomen, an ironmonger, and John Clowley, a glazier, at Dartmouth, about 35 years ago removed the objections, by improving it to its present state, or rather by inventing a new machine, which is the same you perceive herewith.

"This improvement differs much both in point of method, and in regard to the force of the engine first erected; but yet it is wrought by the same power, which is the expansion of water into steam, raised by fire.

"Now to describe *this engine: B* is a large boiler, whose water is converted into steam. *C C* is the cylinder. *D d* a pipe, about 4 inches diameter, joins them together; on the lower orifice of which, within the boiler, moves a broad plate *E*, be means of the steam-cock or regulator *ro*, which keeps in or lets out the steam occasionally.

"The steam of the boiler ought always to be a little stronger than the air, that, when let into the barrel *C C*, it may be a little more than a balance to the pressure of the external air, which keeps down the piston at *d n*. The piston being by this means at liberty, the pump-rod will by its great weight, of at least 9 or 10 hundred of iron, descend at the opposite end to fetch a stroke; but, as the piston and weights at the other end do not exceed half that weight, the end of the lever at the pump will always preponderate, and descend when the piston is at liberty.

"When the piston, by pulling back the handle *ro* is got up to the *C*, or a little higher, the plate of the regulator stops all communication of steam with the cylinder. Then the lever, commonly called the *F*, under the said handle, must be lifted up, so as by its teeth to turn the key of the injection-cock at *N*, and that will permit the water brought from the cistern *g*, by the pipe *g M N*, to enter the bottom of the barrel at *n*, which jet of cold water being driven all over the cylinder, condenseth the steam into water again by its coldness; and, as by this means its bulk is become 14,000 times less than it had when steam, it makes a *Vacuum* sufficient for the pressure of the atmosphere to act again unbalanced, and to raise the other end of the beam with its pump to discharge the water at *p*. And this whole operation of opening and shutting the steam-regulator and injection-cock, being performed in little more than 3 seconds, it will easily produce 16 strokes in 1 minute.

"The cistern *g* is supplied with water from a well or pit near the mouth *p*, by means of pistons and the pump-rod *k*.

A CALCULATION OF THE POWER OF FIRE-ENGINES.

Diameter of Bore.	Will Hold in a Yard.	Will Draw by a 6-Feet Stroke.	Weighs in One Yard.	At Sixteen Strokes a Minute.	63 Gallons to a Hogshead		In One Hour.		The Depths in Yards.												
In.	Gal.	Gal.	Lb. Aver.	Gal.	Hog.	Gal.	Hog.	Gal.	15	20	25	30	35	40	45	50	60	70	80	90	100
12	14,4	28,8	146	462	7	21	440		18½	21¾	24	28½	30½	32½	34½	37½	40				
11	12,13	24	123,5	338	6	20	369	3	17	19½	22	24½	26½	28	29½	31½	34½	37	39½		
10	10,02	20,04	102	320	5	5	304	5	15½	18	20	22	23½	25½	27	28½	31½	33½	36	38	40
9	8,12	16,2	82,7	259,8	4	7	247	7	14	16½	18	20	21½	23	24½	25	28	30½	33	35	36½
8½	7,26	14,5	73,9	232,3	3	43	211	2	13½	15½	17½	19	20½	21½	23	24	26½	28½	31	32½	35½
8	6,41	12,8	65,3	205,2	3	16	195	2	12½	14½	16½	18½	19	20½	21½	23	25	27	29	30½	32½
7½	5,66	11,3	57,6	181,1	2	55	172	3	11	13½	15	16½	18	19	20	21½	23½	25	27	28½	30½
7	4,91	9,8	50,0	157,1	2	31	149	4	10½	13	14	15½	16½	18½	19	20½	22	24	25½	27	28½
6½	4,23	8,4	43,0	135,3	2	9	128	5	10	12	13	14	15½	16½	18	19	20	22	23	24½	26½
6	3,61	7,2	36,7	115,5	1	52	110	1	9½	11	12	13	14	15½	16	17	19	20½	22	23	24½
5½	3,13	6,2	31,8	99,2	1	36	94	3		10	11	12	13	14	15	15½	17	19	20	21	22½
5	2,51	5,0	25,5	80,3	1	7	66	6			10	11	11½	13	13½	14	15½	16½	18½	19½	20½
4½	2,02	2,4	20,5	64,6	1	1	60	6				10	11	11½	12	13½	14	15	16	17	18½
4	1,6	3,2	16,2	51,2	0	51	48	51					9	10	11	11½	12	13½	14	15	16

Diam. of Cyl., Inches.

AN EXAMPLE FOR THE USE OF THE TABLE.

Suppose you require 150 hogsheads per hour, at 90 yards deep; in the 7th column I find the nearest number 149; and against it, in the first column, I find a 7-inch bore for the pump; then under the depth 90, on the right hand, in the same line, I find 27 inches for the diameter of the cylinder fit to raise 150 hogsheads per hour. And thus any other number in this table may be found.

fastened to the arch *x*, and, that the leathers of the piston *C* may be always air-tight and supple, it is supplied with a small stream of water by the arm *z* from the pipe *M*. The *I* at the top of the cylinder is a cup or hollow to hold the water that lies on the piston, which if it chance to be too full will run down the pipe *V* to the waste well at *Y*.

"*F f* is a pipe about 3 feet long, going a foot within the water in the boiler, to

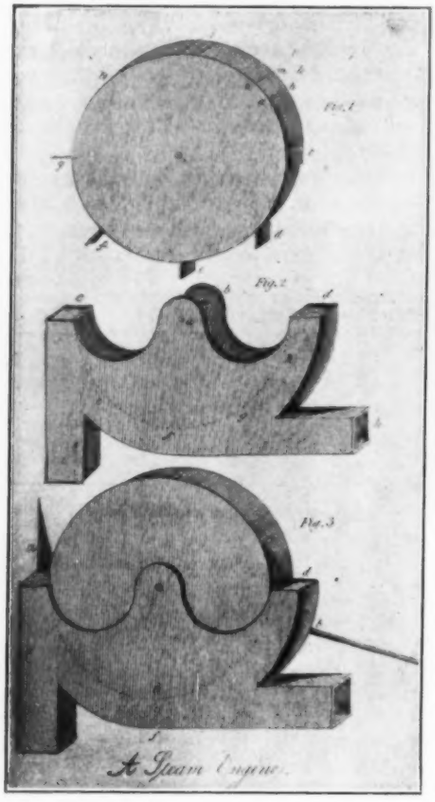


PLATE 4. COOKE'S ROTARY STEAM ENGINE

supply the water which is wasted in generating steam; *F* is a cup at the top of this pipe, and is supplied with tepid water from the cup *I* at the top of the cylinder. *G* represents *two Gages* of different lengths, to prevent the surface of the water from being too low or too high; which is known thus. If the stop-cock of the shorter pipe, being opened, gives only steam, and that of the longer, only water, all is right; but if both cocks give steam, then the surface is too low; or, if both give water, it is too high. Hence the cock which feeds the boiler at *F* may be opened to such a degree, as always to keep the furnace of water to its proper hight.

"*d T Y* is the *Eduction-pipe* to carry off the cold water ejected into the cylinder to condense the steam. It is turned up at the bottom in the well *Y*, with a valve to prevent the air pressing up into the pipe, which might hinder the discharge of the water.

"*b* is the *puppet-clack*, or a valve to try the strength of the steam; which, if it be too strong, or immoderately stronger than the air, may burst the boiler. The method of trying this strength is to lay a piece of lead fastened to the wire upon the valve, and if the steam shall raise up more than 15 pounds weight of lead to an inch square (which is the weight of air, nearly, on every inch (square) it is known to be stronger than the air. For, tho' the steam is of a variable strength, it is never 1/10 stronger or weaker than

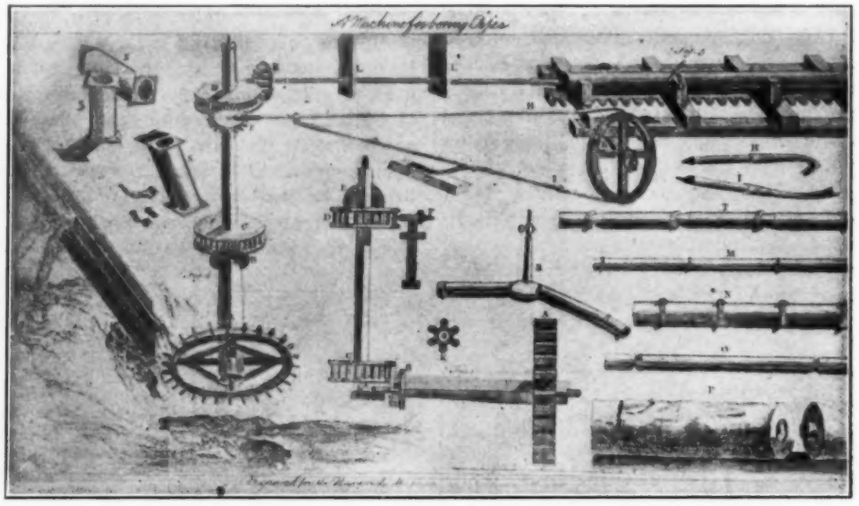


PLATE 5. PIPING AND ITS MANUFACTURE

common air, it having been found by experience, that an engine will work well with one pound weight on every square inch of the valve *b*. A proof that the steam is 1/15 [or 1/13 ?] stronger than common air.

"The small pipe *4*, on which is a small cup, is called the *snifting-clack*, and serves to let out the air injected with the water; which precipitated air is forced into this pipe, as the steam rushes into the cylinder, being a little stronger than the outward air.

"In the infancy of this mechanical invention, the regulator and injection-cock, as I hinted before, were managed by a man, which made it subject to several casualties; but they are now avoided by contriving that the engine itself is made to open and shut them, more nicely than any man whatsoever could possibly pretend to do.

"Thus you see a chain fixed to the arch *Z*, at a proper distance from the arch *P*, to which chain is hung a working-beam *Q*. This beam goes quite down into a hole in the ground, which it exactly fits. This piece has a long slit in it, and several pin-holes and pins, for the movement of several small levers, by which the said cocks are opened and shut, as the service requires. It is called the *Working-plug;* which being once set a going according to art, this engine is most harmless and manageable of all others.

"This machine thus prepared, and set a going, may work about five hours upon a stretch. It will of itself give notice when to stop working; for, if you perceive the *Gages*, as mentioned before give steam, you must replenish the boiler, or it will be in danger of bursting, for want of a due supply of water.

"I will therefore conclude this theory of the *Engine to raise water by Fire*, with Mr. *Henry Beighton's* most curious and useful table to calculate the power of fire-engines, according to the various

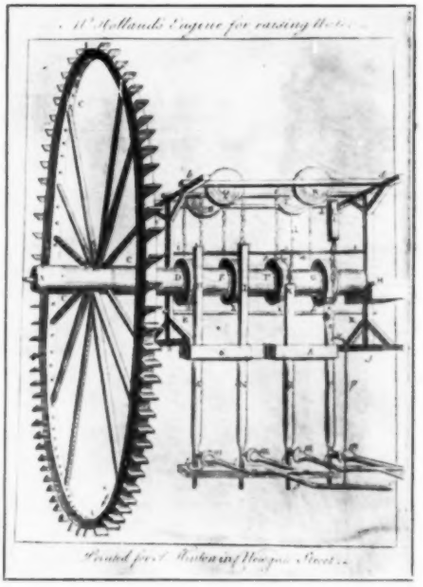


PLATE 6. HOLLAND'S QUADRUPLEX PUMP

diameters of the cylinder, and bore of the pump, that are capable of raising water from 48 to 440 hogsheads *per* hour, at any depth from 15 to 100 yards.

"He founds his calculation upon this principle, That the ale gallon of 282 cube inches of water weighs 10 pounds 3 ounces *avoirdupois*, and a superficial square inch is pressed with the weight of 14 pounds 13 ounces of air, when of a mean gravity. But, allowing for several frictions, and to give a con-

siderable velocity to the engine, it is found by experience, that no more than 8 pounds of pressure must be allowed to an inch square on the piston in the cylinder, that it may make about 16 strokes, about six feet reach, in a minute.

"But it must be also observed that these calculations are only for common practice; for with large boilers, the piston will make 20 or 25 strokes *per* minute; and a pump of nine inches bore will discharge more than 320 hogsheads per hour: So every other size in proportion."

The Savery Engine

Twenty-seven years after its account of the Newcomen engine, the *Universal Magazine*, February, 1774, contained a description of the older type of engine exploited by Capt. Savery. This later article cites the former one as if only a short interval had intervened since its publication, and the incident thus furnishes striking evidence of the lack of progress in steam engineering at that period—aside, of course, from Watt's researches, which are another story. Referring to Plate 2, I quote:

"The method of constructing a fire-engine according to the original institution of the Marquis of Worcester and Captain Savery, wherein the water was to be raised solely by the pressure of elastic vapor or steam, is very useful and very cheap in respect to the other sort, and, when the height to which the water is to be raised does not exceed one hundred or one hundred and fifty feet, then this engine is applicable with great advantage, it requiring but a small fire, not bigger than what is generally used in a parlour-chimney; is of a very simple and easy structure, and admirably adapted for supplying a Gentleman's house with water, and for playing of fountains to a very great height.

"*A* is a boiler; it has a copper cover screwed on, which contains the steam pipe *G G*, and two gage-pipes *C*; on the cover at *C* is a valve, over which lies a steel-yard with its weight to keep it down, the strength of the vapour being this way most exactly estimated.

"The steam is carried from the boiler to a copper vessel *H* by means of the pipe *G G*, and is let into the same by turning the handle *L*.

"The receiver *H* communicates at bottom to the sucking pipe *I B* going down to the water in the well *R*, and above with the forcing pipe *O O*: Between these two pipes are two valves, *N P*, both opening upwards. The steam, being let in upon the water of the receiver *H*, forces it up through the valve *O* and the pipe *O O* to the reservoir *S*. The steam in the receiver is condensed by a jet of cold water coming from the forcing pipe by the small tube *X Y Z*; the handle turned from *Y* admits a passage to the steam into the copper receiver *H*: This steam in the receiver is condensed by a jet of cold water being let in and shut off by a cock at *Y*. The steam, being condensed by this jet, will be reduced within a very small space, and so make a vacuum, upon which the water in the well will rush up the forcing pipe to restore the equilibrium, and thus again fill the receiver *H*, the little air being compressed within a small compass at the top of the receiver *H*.

"*F F* are registers for regulating the fire in the furnace: *B* is a cock inserted into the boiler: *D* is the hearth, and *E* the ash-hole.

"*T V* is a pipe for carrying back the water in the reservoir *S*, when this instrument is used only for making experiments: *Q S*, is the frame of the instrument."

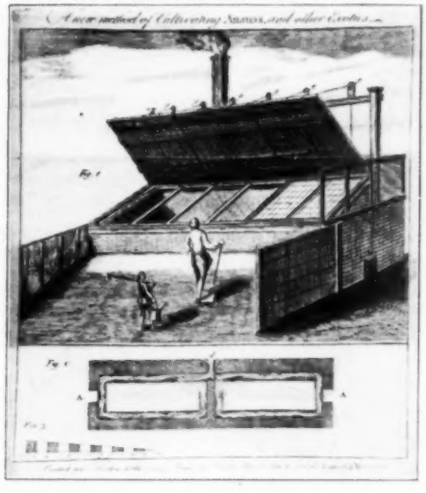


PLATE 7. HEATING A GREENHOUSE

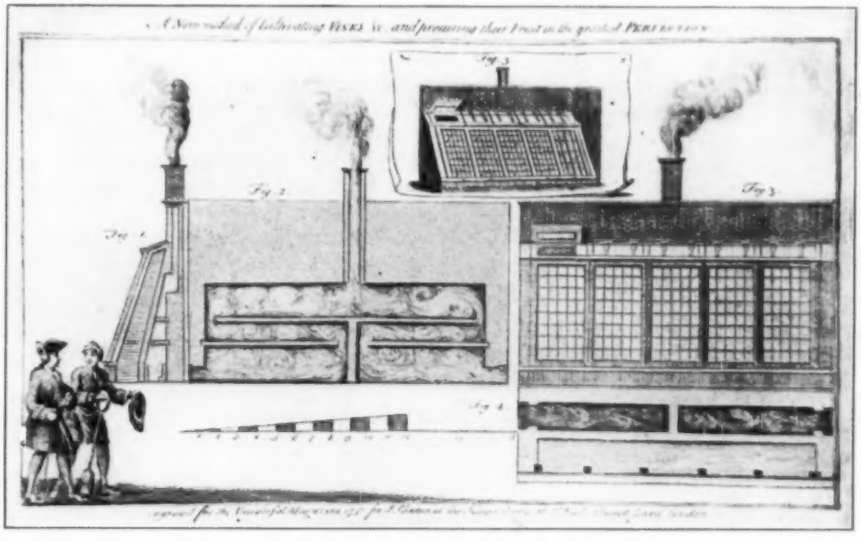


PLATE 8. ANOTHER GREENHOUSE HEATING SYSTEM

Improved Method of Applying the Power of a Newcomen Engine in Mining

In February, 1782, we find shown "A new Machine, or Fire Engine, invented by Mr. Hunt, of London, for draining Mines and Coal Works, and at the same Time raising the Ore or Coal from the Bottom of the Mine to Surface, without the assistance of any additional Fuel."

This improved mechanism dispensed with the use of a number of horses required under the older, and less economical system. To Plate 3 are given the following references:

"(*A.*) The common steam, or fire-engine, for draining mines and coal works.

"(*B.*) The force-pump, which receives the water that is raised from the mine by the main pump (*C.*) and forces it up into the large back or cistern (*D.*)

"(*E.*) The water-wheel. The wheel is of a peculiar construction; having two tiers or rows of buckets, the one formed with their mouths upwards, the other with their mouths downwards; by which means the wheel is made to move alternately by the right and left. On the same axis that carries this water-wheel, another wheel is fixed, (but of smaller dimensions) by which the rope is coiled or wound round, at the end of which are suspended the buckets that bring up the ore or coal. These buckets, by the alternate motion of the water wheel, constantly ascend and descend.

"(*F.*) A strong wooden lever, which being pressed hard against the edge of the water wheel, by means of a man pulling a rope, immediately stops its motion, and gives time to the man who attends to unhook the loaded buckets.

"(*G G.*) These two levers belonging to the sluice-gates, which being alternately pulled up, let out the water on the main wheel or water-wheel.

"(*F.*) A strong wooden lever, which two feet below the surface of the earth, to receive the water that is pumped up from the mine or pit by the main pump.

Into this cistern the lower end of the force pump is fixed."

JOHN COOKE'S ROTARY STEAM ENGINE

This simple machine is found in the *Universal Magazine*, 1796. Referring to Plate 4, the rotor of the engine is a closed cylinder provided with hinged blades which open to a radial position or fold flat on the circumference as the wheel turns. Steam enters the casing at the lower left-hand corner and is exhausted at the lower right-hand corner. The rod *b* is a connecting rod from a crank upon the axis, to work the condenser, i.e., presumably, to drive a circulating pump.

THE ART OF PIPING

A machine for boring pipes was described (February, 1754) and is shown in the accompanying Plate 5. The water wheel in the southwest corner of the picture drives a set of cog gearing with results which are pretty apparent upon inspection. The pipe is made of a wooden log held on a carriage which is advanced to meet the auger by a ratchet-and-pawl feed. The pawls, H_1I_1, which pull and push respectively, are shown in an enlarged detail view. The auger is 9 to 12 feet in length and "of a proportionable bigness."

The same plate contains figures showing several varieties of piping used at the time it was published. *T* is burnt earthen piping; *M* lead piping; *N* flanged cast-iron piping; *O* wooden piping; *P* wooden piping of a larger size. In the northeast corner will be seen some sections of iron piping with bolts and wrench indicating the manner in which they are to be coupled.

HOLLAND'S QUADRUPLE PUMP

An ingenious hydraulic machine was illustrated in August, 1755, designated as "Mr. Holland's Engine, at Lord Tinley's, for raising Water." We perceive in Plate 6:

"*A 2*, the shaft or axle-tree of the engine, 24 feet long and 24 inches diameter.

"*C, C, C, C*, an undershot wheel, 30 feet diameter; its ladles 18 inches broad and 12 feet deep; the fall seven feet.

"*D, E, F, G*, four moveable rings or collars placed on the shaft, three feet diameter, six inches broad.

"*H, I, K, L*, four forcers, rising and falling alternately by means of those collars, having four chains fastened to the collars and the tops of the forcers, as represented at *W, X, Y, Z*. The forcer *L* is cut off to shew the chain more distinct. As the collar *G* moves (with the wheel and axis) half-round towards you, the chain *Z*, fixed at one end to the lower part of the collar *G* at *2*, at its other end at the top of the forcer L_1, will pull down the forcer L_1 four feet and a half; and at the same time, a chain *I*, fixed to the head of the forcer L_1, and to the head *K*, pulls up the forcer *K* four feet and a half; by which time the collar *G* will have carried its trigger *2* up to the bar *i i*, which will unlock its trigger; and the trigger *3*, in the collar *F*, will be brought backward down to *Y*, and there lock the collar *F*. Then, the motion continuing, *K* will be depressed four feet and a half, and the chain *I I*, over the pulley *R*, will raise *L* four feet and a half. And thus the two forcers and collars continuing rising and falling, moving forwards and backwards, locking and unlocking alternately.

"And in like manner, the other two collars, *D* & *E*, move with their forcers, *H* and *I*.

"But to prevent one collar's moving the backward way, faster than the other moves forwards, there is a gauge-chain *4*, fixed to the collar *G*, passing over another pulley *T*, to the collar *F* at *5*, which regulate their motions. These chains are lengthened or shortened by screws, as occasion requires.

"*M, N, O, P*, are four brass cylinders, or pumps, seven feet long; the bores of *M* and *N* are six inches diameter, and those of *O* and *P* seven inches and one-quarter; having, at *l, l, l, l*, each a valve below, which are for taking in the water; and at *m, m, m, m*, valves in the horizontal parts.

"The branches *mn, mn, mn, mn*, communicate the water of their two forcers by *mn, mn*, and so with two pipes, *o, n*. These two pipes *o, n*, join together, at a small distance beyond what is represented on the plate, so that the whole water is forced along one pipe; which makes a jet *d'eau* of seventy feet, and raises the water to the house about seventy feet perpendicular.

"Ninety-five hogsheads are forced up, per hour, to the jet *d'eau*, and forty-seven to the garden.

"*g, h*, are two cisterns, supplied by a pipe *p*, to keep the forcers or pistons always wet.

"*a b c d e f* is a frame of wood to carry the pullies *Q, R, S, T*, and the bars *i, i*, and *K, K*.

"The water-wheel goes about five times per minute to force the water to the house; and three, when the water is raised eighty feet to the gardens."

I would respectfully call Mr. Holland's attention to a book of machines published by Agostino Ramelli in 1588, which shows a pump of startling similarity in appearance.

"MACHINE TO TRAVEL WITHOUT HORSES"

The foot-power cycle, even with some of its more complicated modern features, was known long ago. Several such vehicles are described in the *Universal Magazine*. One of them, illustrated in 1774, was the invention of Mr. Ovenden. It comprised a four-wheeled carriage in which one or two gentlemen could ride at pleasure while a footman, seated behind, trod upon levers actuating the rear axle by ratchet clutches after the manner of the old "Star" and "Springfield Roadster" bicycles of our boyhood days. "The above machine," says the writer, "is doubtless the best that has hitherto been invented, since it is capable of travelling with ease, six miles an hour; and, by a particular exertion of the footman, might travel nine or ten miles an hour on a good road, and even would go up a considerable hill where there is a sound bottom. But this carriage is in general only calculated for the exercise of Gentlemen in parks or gardens, for which it answers extremely well."

One might have supposed that it was the footman who got the exercise.

FURNACE CONSTRUCTION, VENTILATORS, ETC.

Long before the days of steam heating the art of warming greenhouses was known. From the magazine for March and May, 1751, are taken two illustrations showing hothouses with furnaces built into their walls, and the arrangement of the flues. See Plates 7 and 8.

Nor were there lacking power-driven blowers for ventilating purposes. Such a system was installed for changing the air of Newgate prison, which had become a stench in the noses of citizens dwelling in its vicinage and, worse yet, found its way into the courthouse, jeopardizing the health of honorable judges and counselors learned in the law. To these circumstances may be attributed the philanthropy which prompted the installation, for it would have been more consistent with the penal discipline of that period to pump foul air into the jail than to remove it.

The ventilating blowers, as described in the magazine for June, 1752, and April, 1764, comprised rectangular boxes with hinged diaphragms inside and crude valves. On the prison building, adorned with statues of Justice, Mercy, Truth and Liberty, was mounted a windmill to drive the blowers *when the wind blew*. The system did not prove a wild and delirious success.

I fear that the editor will not allow me space to describe any more of the antique mechanical contrivances that are found in the volumes of the old magazine. Among the subjects described and illustrated are a windmill in a smokestack; a testing outfit for "examining the goodness and strength of ropes;" a rolling and slitting mill; a paper mill; the working of iron mines; clock and watch manufacture and electrical experiments; also many improved agricultural machines.

To the eighteenth century must be allowed credit for making the steam engine an accomplished fact, and that is no small praise. Yet otherwise we are impressed with the stagnancy of mechanical arts in that period. From the eighteenth to the nineteenth centuries engineering progress was vastly greater than for several hundred years previous.

An Interesting European Vertical Miller

Carefully Worked-out Details, Ease of Operation, Convenience and Adaptability Characterize This Design. Several Attachments Shown

SPECIAL CORRESPONDENCE

Assembly and detailed illustrations of a vertical milling machine are shown by the halftones, Figs. 1 to 13, inclusive. The machine is a product of the Société Alsacienne de Constructions Mecaniques of Grafenstaden, Alsace, and is known as machine No. 8103 M. It is built for either a constant-speed drive, as shown at the left in Fig. 1, or with a direct-connected, variable-speed motor, as shown at the right of the same view.

The general details are well brought out by these two illustrations. It will be seen to consist of a rigid pillar, supported from a base, which also carries the pulleys and gear box in the case of the belt-driven machine, and the motor, connecting gearing and gear box in the case of the motor-driven machine. In both cases the oil tank is not made a part of the main machine casting, as in much American practice, but is in the nature of a separate casting, placed at a convenient point beside the machine. The left-hand view of Fig. 1 shows the piping to and from this oil tank, together with the location of the circulating pump.

As all of the important parts of the mechanism are shown in detail in the following illustrations, it is unnecessary to dwell longer upon the general features of the machine, except to give the over-all dimensions. The effective length of the table is 940 millimeters, or about 37 inches. The distance from the face of the pillar to the center line of the spindle is 400 millimeters, or about 16 inches. The vertical travel of the spindle is 150 millimeters, or 6 inches. The maximum distance between the end of the spindle nose and the top of the table is 420 millimeters, or 16½ inches. The traverse of

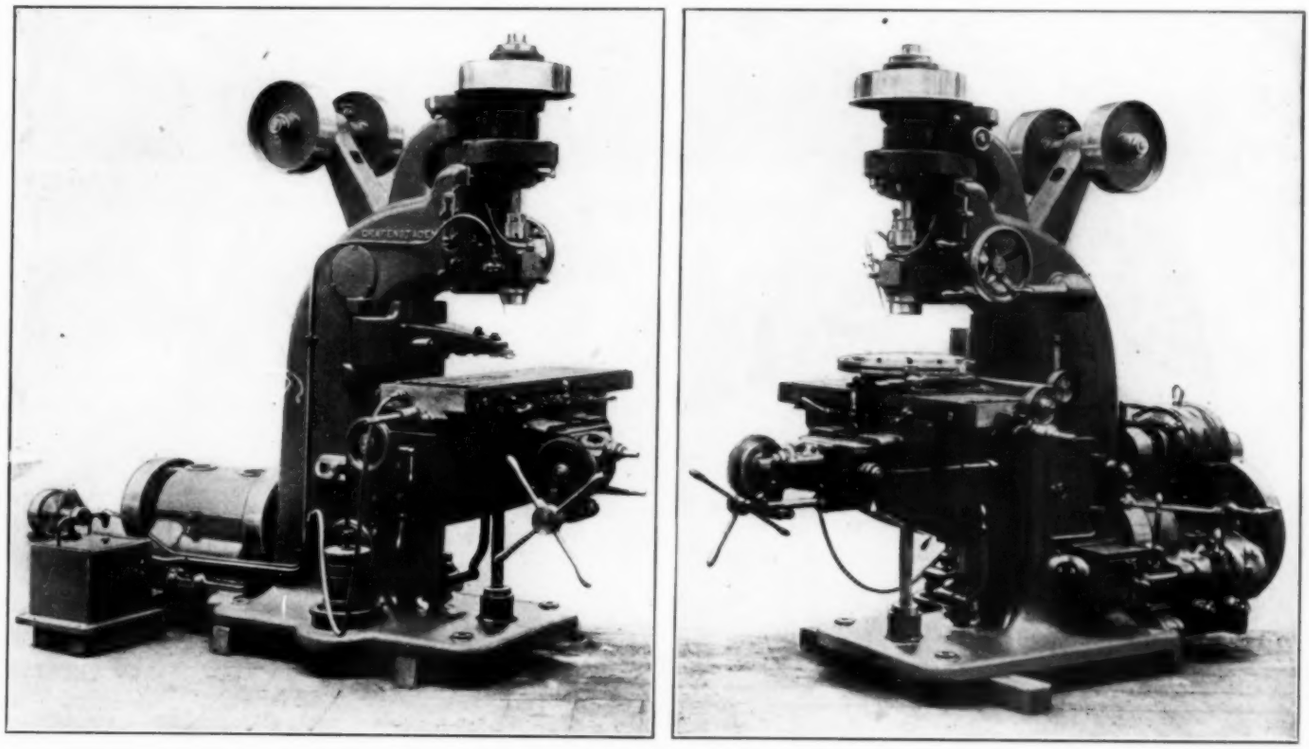


FIG. 1
AN EUROPEAN VERTICAL MILLER

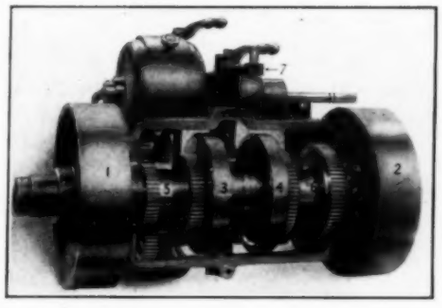


FIG. 3

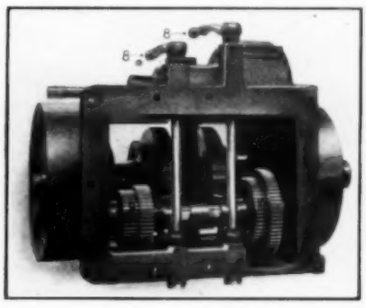


FIG. 2

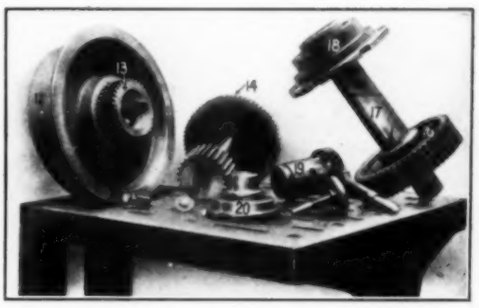


FIG. 4

TRANSMISSION AND SPEED-VARYING MECHANISM

the table either side of the center line of the machine is 760 millimeters or about 30 inches. The width of the driving belt is 100 millimeters, or 4 inches.

The Transmission Mechanism

The transmission mechanism, or speed-varying mechanism, is shown by Figs. 2 and 3, of which Fig. 2 is a view in plan, and Fig. 3 from beneath. Here, 1 indicates the driven pulley belted from an outside source of power, or the driving pulley of the machine; 2 is the driving pulley carrying the belt that passes over idlers to the pulley on the cutter spindle. Frictions are indicated by 3 and 4, of which 3 is the friction that drives through the speed-changing gear, while 4 drives without gears. This system of gears is indicated in turn by 5, 6, 9 and 10, and is so arranged that there are four different speeds from its use. By 7 is indicated the friction-clutch operating lever, by means of which this clutch can be thrown into engagement with either disk 3 or 4 as desired. The shaft through which motion is transmitted to the feeding mechanism is indicated by 11. This shaft is driven through a system of gearing from gear 5, as better shown in Fig. 2.

The Cutter Spindle and its Mechanism

The cutter spindle is indicated by 24, in Fig. 5, and its accompanying mechanism is shown in Figs. 4 and 5. Here, part 12 is the driven pulley on the cutter spindle; 13 is a pinion made fast to this pulley and forming the driving member of the back-gear train. The other pinions and pulleys of this train are 14, 15 and 16; 17 is a quill that surrounds the cutter spindle, carrying on one end the gear 16, one of the gears of the back-gear train, and on the other end part 18 of the back-gear operating mechanism. Attention should be called to the oil grooves that are cut on part 17. This detail of design and execution shows on many of the other parts of this vertical miller and is an indication of the care with which the machine has been designed and is built. At 19 is seen the back-gear operating lever with a long eccentric hub.

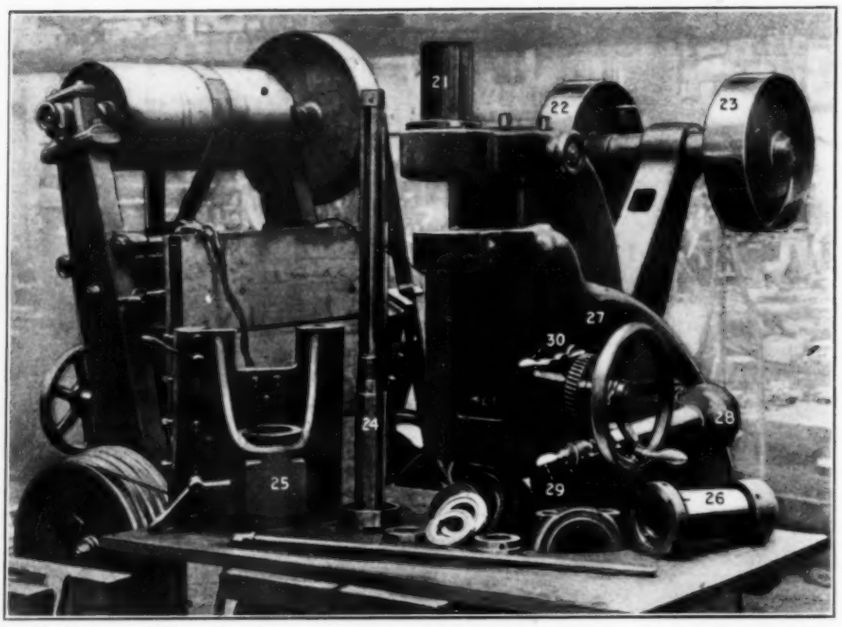


FIG. 5. DETAILS OF HEAD, SPINDLE AND BEARINGS

Turning now to Fig. 5, the bearing for driving pulley 12 is indicated by 21. The two idler pulleys of the system are indicated by 22 and 23. The cutter spindle we have already referred to, and its head and main bearing is shown at 25. The adjustable box that enters this head is indicated at 26. The various operating parts for the vertical feed of this head are indicated by 27, 28, 29 and 30. Their specific functions do not need to be detailed.

The Feed-changing Mechanism

Two views of the feed-changing mechanism are shown by Fig. 6. It consists of

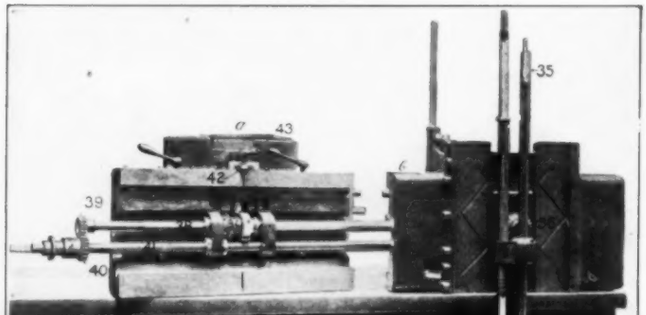


FIG. 7

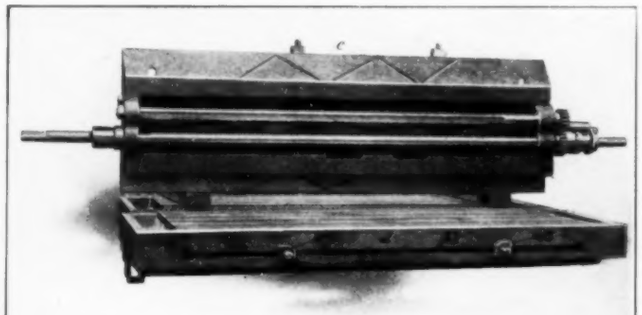


FIG. 8 THE SADDLE AND TABLE

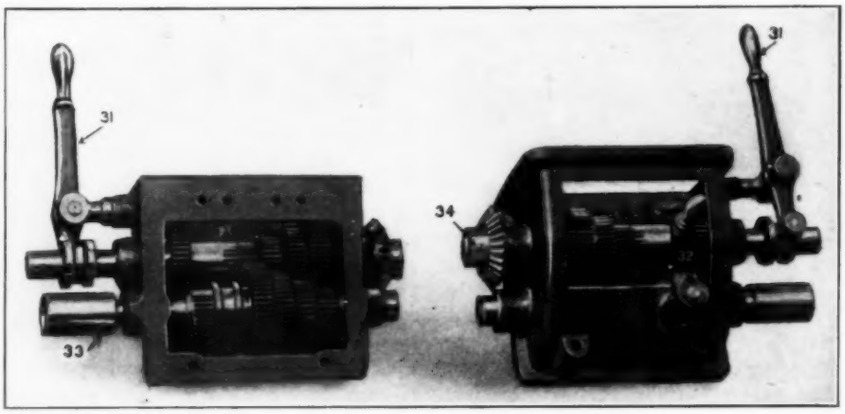


FIG. 6. THE FEED BOX

PUBLIC LIBRARY,
No. 605 A5M
DETROIT, MICH.

the familiar twin conical nests of gears with the two operating levers 31 and 32. The driving shaft of this mechanism is 34, which carries a coupling to connect with shaft 11 of Fig. 2. On the opposite end of the other shaft of this feed-changing device is a bevel gear, indicated by 34. From this motion is transmitted directly to the feed-operating mechanism. The precise position of this bevel gear can be seen by referring to the right-hand view in Fig. 1, where a miter-gear guard is seen near the bottom of the pillar and in front of the box surrounding the feed-changing gears. This mechanism produces the changes of feed.

The Knee Saddle

Two views of the knee saddle or carriage are shown by Fig. 7, in which *a* indicates the upper face containing the table-operating screw and shaft, while at *b* is seen the lower face, that is, the surface which is in contact with the knee and the screw which operates the knee-elevating device. Here, 35 is the feed shaft for both the longitudinal and cross-automatic feeds of the table. Parts 36, 37, 39 and 40 form the automatic, longitudinal table feed; 42 is the trip and 44 the clutch for controlling this automatic feed, while 43 is the hand lever for disengaging the longitudinal feed if desired.

The Table

Fig. 8 shows two views of the table, of which *c* is an underneath view showing the bearings of the table upon the saddle; *d* is a side view of the table, from which its relative thickness can be seen. At 45 and 46 are indicated the longitudinal feed-stop dogs.

Rotary Milling Attachments

The rotary milling attachment with which this machine is provided is shown by Fig. 9. Here 48 is the feed shaft, 52 the stud for a handle for hand feeding, 49 the automatic feed-trip dog, and 50 the roll against which it strikes and by means of which it operates the lever 51 to throw out the feed; 51 is also the hand lever by means of which the feed can be disengaged.

Horizontal Milling Attachment

Two views of the horizontal milling attachment are shown by Figs. 10 and 11, the distinction being the rigid outboard support for the cutter arbor in Fig. 10. The function of this attachment and its method of fastening to the machine are obvious.

The Knee

The last detailed view, Fig. 13, shows the milling-machine knee. The stud for controlling the vertical movement of the knee is indicated by 55, similarly the stud for controlling the cross-travel of the saddle is indicated by 56. By 57 is indicated a pilot wheel, used for returning a heavy counterweight, which can be seen in the left-hand view of Fig. 1, through the mechanism of a gear meshing with a pinion on the shaft of the pilot wheel, and a flexible band, 58 and 59. This weight is used with the profiling attachment.

FIG. 9. THE ROTARY ATTACHMENT

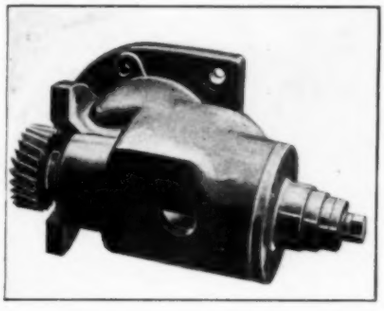


FIG. 10

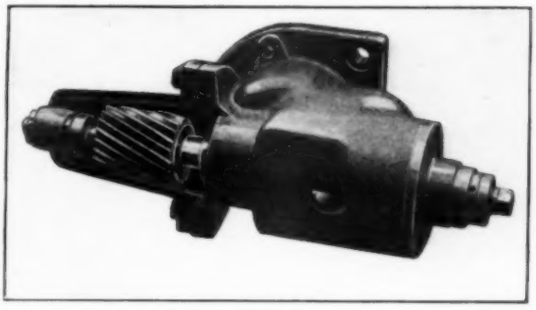


FIG. 11

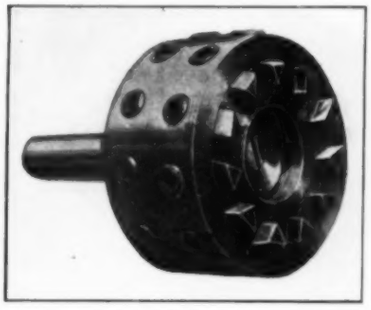


FIG. 12

TWO HORIZONTAL ATTACHMENTS AND AN INSERTED-TOOTH CUTTER

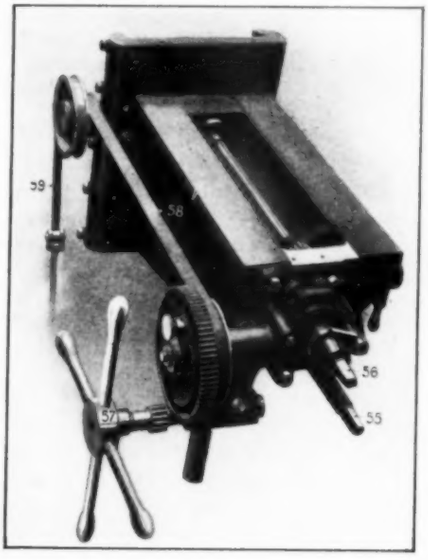


FIG. 13. THE KNEE

An Inserted-tooth Milling Cutter

An inserted-tooth milling cutter is indicated by Fig. 12. It consists of a heavy hub or disk, into which triangular-shaped blades are inserted and fastened by means of heavy set screws. This hub is provided with a threaded taper shank.

According to a statement read in a paper presented before the Central Railway Club the decision made by the late president Cassatt, of the Pennsylvania system that with the completion of tunnel systems into New York City none but all-steel coaches should be used therein is being closely adhered to. These sub-river tunnels have, therefore, been factors in the introduction of steel in coach construction, but the primary idea is nevertheless the safeguarding of the passenger. The growing scarcity of long timber for sills and the reduction in cost of maintenance of steel over wooden cars may both be considered as minor causes in the introduction of steel.

Favorable reports in making high-speed steels, according to a writer in *Stahl und Eisen*, were obtained with powdered ferro-tungsten produced by Chemische Fabrik Fuerth. Analyses show that it contains 85 per cent. of tungsten, 0.30 carbon, 0.45 silicon, 0.45 manganese, 0.25 aluminum, calcium and magnesium, and 0.01 of sulphur. Tin, phosphorus, copper and arsenic could not be detected. Ferro-tungsten melts at considerably lower temperature than tungsten metal, and it is far less subject to oxidation than the pure metal. Slagging of the tungsten is low, so that the loss of this dear metal is almost nil. The powdered ferro-tungsten alloys more readily. The segregation is less and the steel is not so much subject to piping.

Comparison of Power Efficiency—No. 2 and No. 2-G B. & S. Automatic Screw Machines

The No. 2-G automatic screw machine shows the adaptation of the constant-speed drive feature to this type of machine, and was recently described in the AMERICAN MACHINIST. The adaptation of this type of drive to screw machines was taken up by Brown & Sharpe Manufacturing Company, and a machine developed and placed under manufacturing conditions in the factory for about two years.

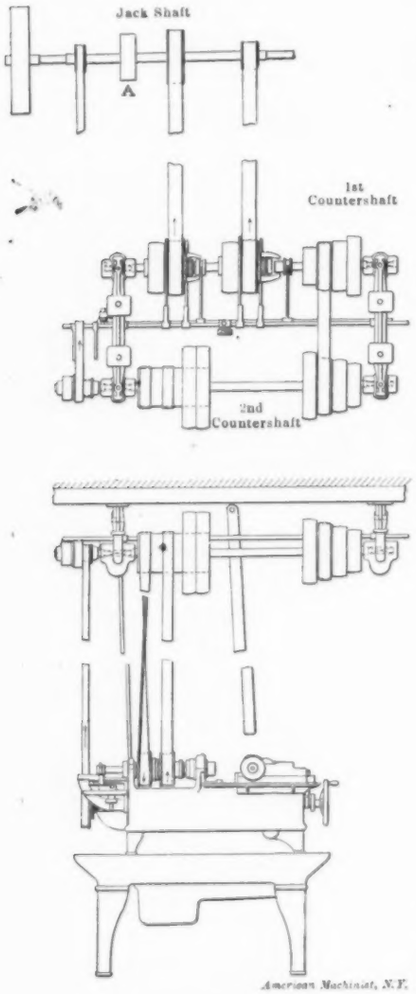


FIG. 1. OVERHEAD WORKS OF A NO. 2 B. & S. AUTOMATIC SCREW MACHINE

The machine proving satisfactory under the most severe conditions, it was decided to place this type of machine on the market. The general advantages of this drive are undoubtedly familiar to all engineers and mechanics, and the results of the tests of the constant-speed-driven screw machine in comparison with the regular belt-driven machine of the same size, comparing their efficiency under various conditions, will be of interest.

As this type of drive is comparatively new in its application to the automatic screw machine, a series of tests was decided upon and made at the factory in order to determine the amount of power consumed or required to operate, under varying conditions, these two types of machines. The machines tested are known to the trade as No. 2 automatic screw machine and No. 2-G automatic screw machine, the latter being of the constant-speed-drive type and of the same capacity as the regular No. 2. The results of these tests were somewhat surprising in that they showed even a greater efficiency for the constant-speed type over the regular belt-driven type than was anticipated, and the results of the first tests were so much in favor of the constant-speed machine that another series of tests was made in order to check the figures obtained by the first series. In these tests a 3-horsepower 115-volt General Electric motor was employed, and for convenience the power was taken from a small jack shaft driven direct from the motor. The machines in question were new machines that had been run a few hours under severe duty, and the overhead works used in connection with the No. 2 machine was one that had been used for several years for this limbering of machines.

Fig. 1 is a diagram showing the No. 2 machine and overhead works and the method of driving this machine from the jack shaft. Fig. 2 shows a section through the spindle-gear case, and represents the mechanism that takes the place of the overhead works on the No. 2 machine.

Referring to Fig. 1, the constant-speed machine was driven direct from the pulley *A* on the jack shaft to the driving pulley on the machine. The first step in conducting these tests was to determine the power consumed by the motor and jack shaft, which was found to be about 500 watts. This is included in the subsequent readings of the voltmeter and ammeter and should be subtracted from their product in determining the final results. The next step was to determine the power necessary to run the loose pulleys on the overhead works of the No. 2-G. This is the power that would be consumed while the machine is standing idle.

The reading of the volt and ammeters taken at different times showed:

6½ amperes 116 volts = 754 watts.
7½ amperes 113 volts = 847 watts.
6½ amperes 112 volts = 728 watts.

3)2329

776 average watts.

As a comparison with this, tests were made to determine the power necessary to drive the loose pulley on the No. 2-G machine. This would show the power consumed by this machine when it is standing idle:

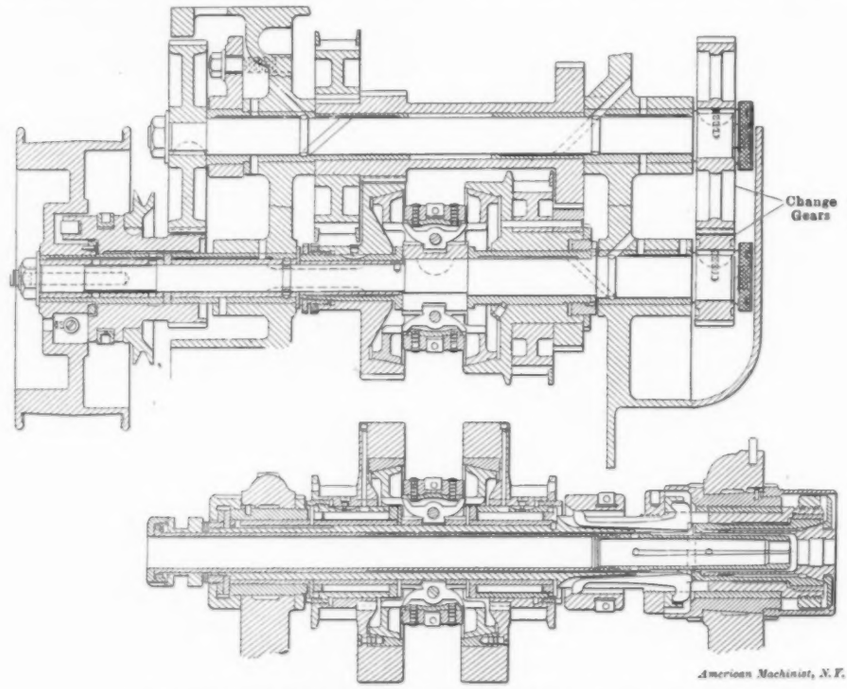


FIG. 2. SECTION THROUGH GEAR-CASE AND SPINDLE OF A NO. 2-G B. & S. AUTOMATIC SCREW MACHINE

5¼ amperes 113 volts = 621 watts.
5½ amperes 117 volts = 643 watts.
5 amperes 110 volts = 550 watts.

3)1814

605 average watts.

Subtracting 500 watts, the power consumed by the motor and jack shaft from each one of these results, and dividing by 746 to reduce to horsepower, we find that the No. 2 machine while standing idle consumed 276 watts, or 0.37 horsepower, and the No. 2-G. machine 105 watts, or 0.14 horsepower. That is, it takes 164 per cent. more power for the No. 2 machine while standing idle than it does for the No. 2-G machine. It is plainly enough to be seen why this is so as there

are three loose pulleys and continuous-running belts on the No. 2 machine, and only one on the No. 2-G machine.

Another test was made to determine the power consumed by the complete machines running at high speed without doing any cutting. The No. 2 machine was run at 1350 revolutions per minute and the No. 2-G machine at 1390 revolutions per minute, and the average power computed from several readings was 1145 watts, or 1.54 horsepower for the No. 2 machine, and 857 watts, or 1.15 horsepower for the No. 2-G machine. This shows that it takes 34 per cent. more to run the No. 2 machine than it does the No. 2-G machine at high speed. A test was then taken at slower speeds and even more difference was shown. The No. 2 was run at 518 revolutions per minute and the No. 2-G at 615 revolutions per minute, and the average power was 982 watts, or 1.31 horsepower for the No. 2, and 611 watts, or 0.82 horsepower for the No. 2-G machine at the above speeds.

Tests Under Working Conditions

Probably the most important tests that were made were of the machines under actual working conditions. The machines were tried under about the severest duty that they would probably ever be put to, and to do this the cutting of brass at a very high spindle speed was chosen and the cutting tool a hollow mill. The brass rod 7/8 inches in diameter was turned down to 3/4 inch with a feed of 0.009 inch per revolution of the spindle, and the spindle speeds 1350 and 1390 revolutions per minute. The experiments were then carried farther by testing the cutting of steel. A 7/8-inch rod of cold-rolled steel was turned down to 3/4 inch by a hollow mill with a feed of 0.005 inch per revolution of spindle, and spindle speeds of 518 and 615 revolutions per minute. A high-speed steel hollow mill was used and the surface speed was 120 to 140 feet per minute. In cutting brass the constant-speed machine showed up to advantage in that it held its speed better than the other machine. On the older type of machine it was necessary to keep the belts quite tight, and even then the speed dropped from 1350 to 1068 revolutions per minute while under the cut, while on the constant-speed machine it only dropped from 1390 to 1368 revolutions per minute. On the slower speeds the constant-speed machine shows to even better advantage as we then begin to get the benefits of a back-geared machine. Exactly the same cams and hollow mills were used in the one case as in the other.

The average results for cutting brass were 3410 watts, or 4.6 horsepower for the No. 2, and 3042 watts, or 4.1 horsepower for the No. 2-G machine.

For cutting steel the average results were 1806 watts, or 2.4 horsepower for the No. 2 machine, and 1376 watts, or 1.84 horsepower for the No. 2-G machine.

The results are presented in table form:

	Horsepower, No. 2.	Horsepower, No. 2-G.	Per Cent. Difference.
To run loose pulley on overhead works.....	0.37	....	....
To run loose pulley on machine.....	....	0.14	164
To run machine at 1350 and 1390 revolutions per min.	1.54	1.15	34
To run machine at 518 and 615 revolutions per min.	1.32	0.82	61
To cut brass at 1350 and 1390 revolutions per min.	4.6	4.1	12
To cut steel at 518 and 615 revolutions per minute..	2.4	1.85	30

RESULTS OF POWER TESTS OF TWO BROWN & SHARPE AUTOMATIC SCREW MACHINES.

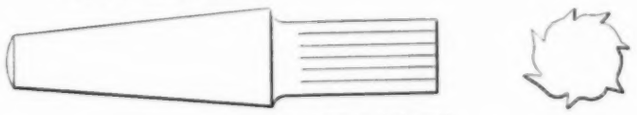


FIG. 2 (Enlarged)

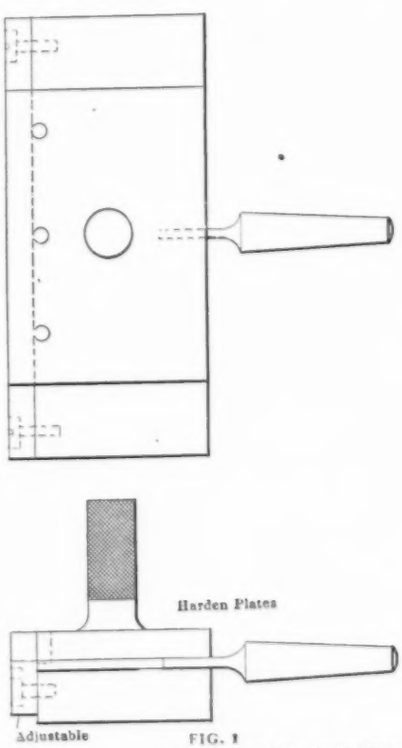


FIG. 1

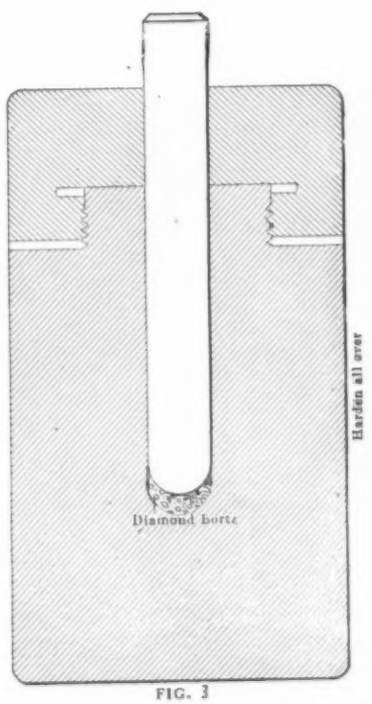


FIG. 3

American Machinist, N. Y.

DIAMOND LAPS, CHARGING PLATES AND CRUSHING MORTAR

In summing up the results it will be noticed that they are all in favor of the constant-speed drive, and that the gain varies inversely with the work done by the machines. The working conditions of these two machines were as nearly alike as it was possible to make them, and they were run under more severe duty than they would probably be called upon to perform commercially.

According to the *Railroad Age Gazette*, it has been suggested, in connection with the subject of the protection of steel by painting, that painting steel sheets while they are hot would be of great advantage in preserving the metal.

Grinding Small Holes with Diamond Laps

By W. H. Ebelhare

When one suggests the use of diamond powder in the machine shop for the above purpose the reader is apt to pass on believing the cost prohibits its use. First I wish to state that the diamond used for this purpose sells in a varying market from $0.85 to $1 per carat—this is no typographical error, eighty-five cents to one dollar. It possesses the same hardness and cutting qualities as the diamond of the gem class selling at $125 per carat, but is not quite so hard as the black diamond used in rock drilling. Diamonds are divided into three principal classes: First, the beautiful white used exclusively for ornamentation; second, the black diamond, selling in the neighborhood of $90 per carat; third, that which we reduce to powder and use as an abrasive, at the modest price of 85 cents per carat. This low price is due to the number of flaws contained, suggesting a shattered condition which latter makes it readily reducible to powder. In color they are varied, the majority gray, then brown, some yellow and a few pinkish. Some are of

good structure but the color is bad. In short, into this class of diamonds are entered all stones which by color, structure and hardness are unfit for the higher classes.

In the grinding of small holes, say from 0.014 to 0.125 inch, diamond offers the most economical means obtainable. This, of course, applies to work ground to accuracy. The sizing of holes in spring chucks made for watch factories and the trade is done with diamond powder. Here we have not an occasional job, but a regular standard product. Undoubtedly men have time and again experimented with diamond powder and discarded its use. In such cases I believe they either did not use the proper grade of diamond, did not charge the lap properly, or ran at too low a speed.

We must acknowledge that the diamond is sufficiently hard and its structure tough enough to withstand the pressure. Laps are charged by two methods, "hammering" and "rolling." The small delicate ones, say from 0.011 to 0.040 inch diameter, are rolled between two plates as shown in Fig. 1. Diamond No. 3 is placed on the lower plate and is carried to the upper by the lap in the act of rolling. Gentle pressure is all that is necessary for the smaller one but the 0.030 to 0.050 inch sizes will stand considerable more. A small watchmaker's hammer will take care of the larger sizes say from 0.050 to 0.125 inch. The lap is supported on a hardened block. The diamond, mixed with a small quantity of oil to make it adhere, is applied to the lap and block and struck light blows with a small hammer.

The laps are made of soft steel, permitting firm imbedding of the grains in the lap. Tool steel is hard, offering too much resistance. While the latter is stiffer and one is apt to insist on its use for the very small laps, I believe this advantage is offset by the difficulty found in retaining the abrasive. Diamond will cut beautifully if not crowded, and soft steel is well capable of doing the work.

As the laps approach an eighth of an inch and more in diameter the method of setting the grains is the best practice. This is accomplished by supporting the lap on a block of babbitt and with chisel and hammer cutting longitudinal grooves in the lap as in Fig. 2. The more grooves cut the better, and the heavier the bur the more securely the diamond becomes imbedded. Fill the lap with No. 0 or No. 1 diamond as experiment may determine, and hammer on a hardened block. Here the diamond is well supported. The hammering may force the grains under the surface, which is an advantage rather than otherwise. The lap is soft and soon wears down to the diamond which remains supported to the cutting edge. A lap charged in this fashion will cut fast and will throw sparks. I wish to emphasize that the proper speed must be maintained. Many mechanics will have a small traverse grinder belted to run say, 18,000 revolutions per minute, with an emery wheel two to three inches in diameter, and then drop down to a diameter of ⅛ inch without increasing the speed. This error, of course, is due to thoughtlessness. A lap 1/16 inch diameter should run at a speed no less than 40,000 to 50,000 revolutions per minute and care should be taken to see how lightly you can approach your work and do the cutting. The laps when applied to the spindle, naturally run out; the truing can then be done with a small hammer or by any convenient means. Even then one-half is apt to be doing all the work; as this wears away tap the other half into prominence.

The grade of diamond determines the fineness of cut or finish. No. 0 is coarse and cuts fast and naturally leaves a rough finish. Nos. 1, 2 and 3 give a finish in proportion to their finer grains. Experiment must determine the finish you desire. After charging the lap should be washed in a small dish of benzine with vigorous application of a tooth brush, also the rolling plates should be cleaned if you desire to change to a finer grade. After considerable accumulation this benzine can be poured off and the powder washed in clean benzine, this to be poured off after the diamond has precipitated and the latter then allowed to dry. If it does not dry readily, wash again. The process of grading can then be carried through again.

Firms making a constant use of this abrasive always buy it in the bortz and reduce it to powder themselves, thus insuring the best satisfaction both as to quality and grade. The usual method employed is to crush the diamond in a mortar, as shown in the illustration, Fig. 3, which is drawn to size. The mortar can be held in the lap, or supported on a bench and the plunger struck lightly with a ¾-pound hammer, the length of time governed by the force of the blow.

As a first trial, place about one carat in the mortar and strike 25 light blows; then scrape the powder free from the bottom and sides and empty into a receptacle about the size of a tea cup (the latter will do) three-quarters filled with the best olive oil; stir thoroughly and allow precipitation, say for three minutes, then pour into another dish, using care, however, not to pour too closely, otherwise you are apt to have a few coarse grains in the finer grade. The residue in the first dish, which we will label No. 0, is held for extremely coarse grinding,or it is washed and repounded. The second dish allow—after stirring—to stand eight minutes; pour off and label the residue No. 1. Continue according to the following table:

No.
0 = 3 minutes precipitation.
1 = 8 minutes precipitation.
2 = 20 minutes precipitation.
3 = 40 minutes precipitation.
4 = 1½ hours precipitation.
5 = 10 hours precipitation.
6 = until oil is clear.

Naturally the amount of pounding determines the grade, and the residue is the index to future hammering in powdering. It is rather unsatisfactory to go through the above table with but one carat; 15 to 20 carats or more, is very satisfactory.

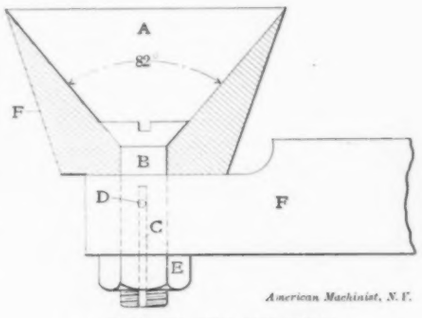
Nos. 1, 2 and 3 are used for grinding. Nos. 4, 5 and 6 smeared on boxwood revolving at a good speed give a high degree of polish. No. 4 will be a trifle streaky. No. 6 gives a high, mirror polish. Diamond bortz or diamond powdered can be purchased at jewelers' supply houses.

It may interest readers to learn a good method of determining the genuineness of a stone represented as a diamond. Drop a real diamond and an imitation into a glass of water. The latter will be distinctly visible while the former will blend with the water and almost vanish. Dry the two and drop a tiny drop of water on the flat side of each. On the diamond only will the drop maintain its globular form.

A Turning Tool for Wood

By E. A. Dixie

Various tools for turning wooden rolls have been shown from time to time and to those interested I suggest the one shown in the line cut. *A* is the cutter (shown in section) which is made of either carbon or high-speed steel. For turning fiber the latter would possibly be better. It is bored at an angle of 82 degrees so as to accommodate the head of a regulation flat-head machine screw *B* which has a spline *C* on its body in which the pin *D* slides, this keeps it from turning when



A FORMING TOOL FOR WOOD

the nut *E* is tightened. *F* is the body of the tool, made preferably of machine steel. The face angle *F* can be made to suit the material being turned. In the cut it is about 40 degrees included angle, which would be about right for maple and similar hard woods. Softer woods might require a more acute angle both inside and out. A cutter *A*, 1½ inches diameter, would have nearly 5 inches of cutting edge. When dull at one point the nut *E* is slackened and the cutter turned so as to present a new cutting edge to the work. When the whole cutting edge is dull the cutter is removed and ground on the face *F*.

Gages and Fixtures for Testing Ball Bearings

The Tools Used in the Inspection of Ball Races and Assembled Bearings Include Novel Snap Gages and Bench Fixtures Fitted with Test Indicators

EDITORIAL CORRESPONDENCE

The Hess-Bright Manufacturing Company, Philadelphia, Penn., uses in its manufacturing and inspection departments a variety of accurate gages and testing fixtures, the chief features of which are illustrated in the accompanying engravings.

In Fig. 1 a view is presented of an inspector's bench upon and behind which are grouped a number of accurate tools and appliances which are regularly used in testing the ball bearinigs made by this concern. Among these testing devices will be noticed several fixtures equipped with dial gages, to which reference will be made at another point in this article; a set of thin disk gages for testing the grooves in ball races; two Shore scleroscopes by means of which the ball races are tested for hardness; a set of Swedish combination gages; numerous plug and ring limit gages, etc. A rack in this room in which plugs and rings are kept is illustrated in Fig. 2 and a number of plugs of large diameter are shown on the different shelves. Some of these plug gages are of diameters ranging up to eight or ten inches. Their bodies are lightened in the manner indicated, the central web being comparatively thin and the finished surface narrow. They are of the tandem type with the periphery ground to two diameters representing the minimum and maximum limit sizes; and in all cases it may be stated, the tolerances allowed in the bore of the races for which these gages are used are very close.

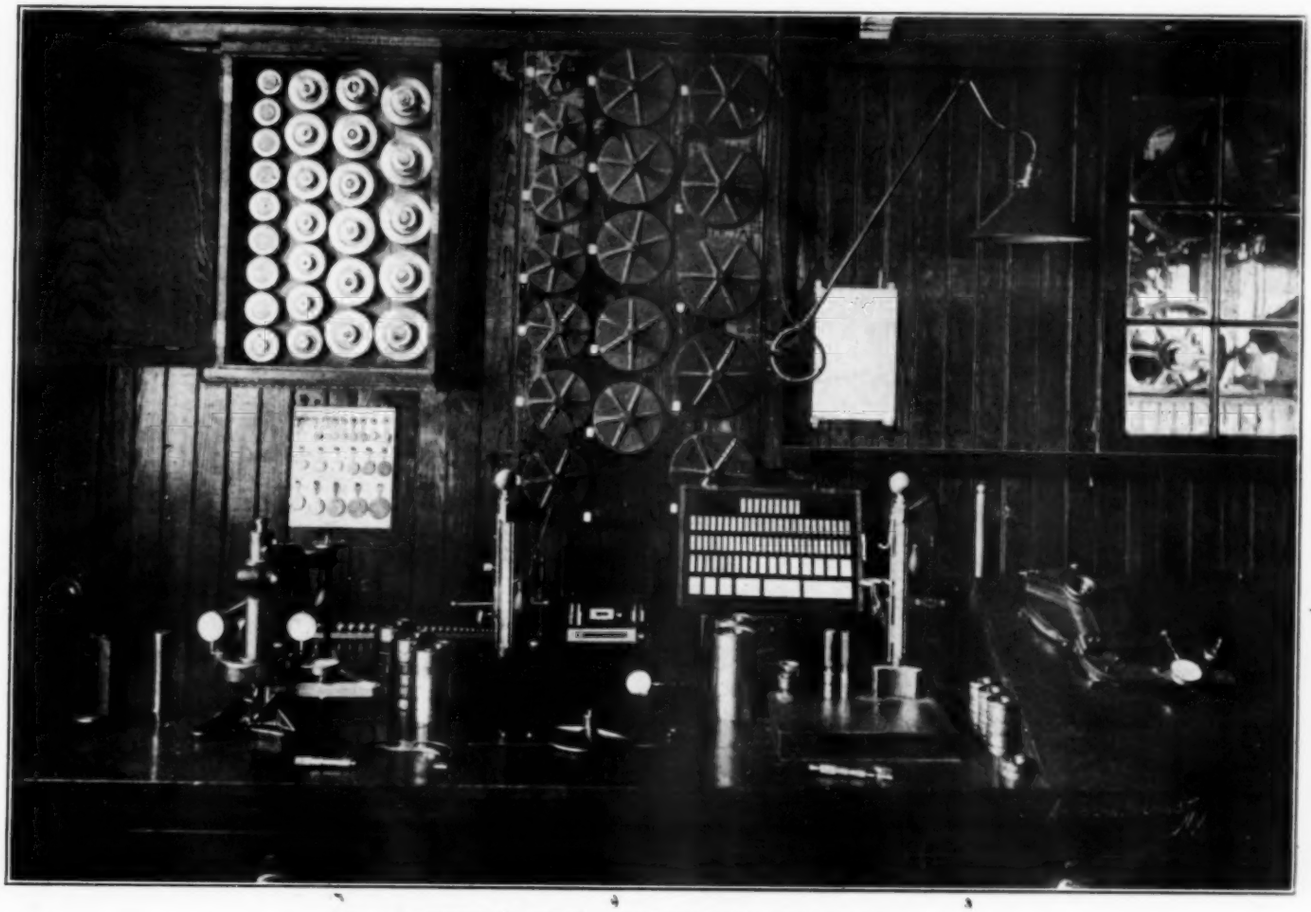


FIG. 1. INSPECTOR'S BENCH—HESS-BRIGHT MANUFACTURING COMPANY

Built-up Snap Gages

Another view in this department is shown in Fig. 3, where several hundred limit snap gages of an interesting type are illustrated in their racks along the walls. These gages are of sectional construction and made from designs originated by the Hess-Bright Company. Their features are shown more clearly in Fig. 4, which illustrates a complete set of gages for one size of ball bearing, known as the "308." Several ball bearings of this size are shown in the group, which are seen disassembled at the lower left-hand corner. This form of bearing is, of course, familiar to our readers, who will recognize the telescopic separating devices seen in the group of balls which enable the bearing to be assembled without a filling opening in the ring. Other forms of separators or cages are used more generally; however, some bearings of the type shown were going through the inspection department at the time of the visit. In assembling, the inner ring or race, is placed against one side of the bore in the outer race, leaving a gap at the opposite side large enough to admit, one at a time, the series of balls required for the bearing. The balls are then spaced around the ball groove and a separator placed between each pair, a light spring inclosed in each of the spool-like separating devices pressing the two ends of the telescopic affairs in opposite directions and holding them lightly in con-

FIG. 2. LARGE PLUG AND RING GAGES

tact with the ball at either side. The appearance of the bearing with balls and separators in place is well shown by the assembled unit immediately at the rear of the group of parts in Fig. 4.

Gage Construction

Referring now to the snap gages illustrated in this group, these are double-end tools, each made up as represented of two gages fastened together by screws and dowels, each gage consisting of a body and a pair of jaws which are securely attached to the sides of the body by long screws and dowels. Each complete gage then forms a limit gage having one pair of "Go" and one pair of "Not Go" jaws. This method of construction allows either end of the double gage to be corrected for wear without interfering with the other end. All that is necessary in correcting a gage is to remove the two jaws which may be worn and grind or lap their inner surfaces straight across from end to end. As the body of the gage is not changed in any respect it always spaces the jaws the exact distance apart no matter how often they may be corrected.

An ingenious and most important feature of these gages is the means provided for holding the jaws snugly to the body so that when in use they will not "lift" from their seats. In order that the long screws which pass through the jaws at one side, then through the gage body and into tapped holes in the opposite jaw, may secure the jaws in position so firmly as to preclude all possibility of their being sprung away from their seats, these screws are slightly warmed and then screwed into place. The contraction which takes place in the screws as they cool, while very slight, is still sufficient to draw the three parts of the gage very firmly together. To remove the screws it is necessary to warm them slightly; to provide for this operation a gap is milled across the gage body, which exposes a portion of the screw at a point near the middle of its length. This gap, as clearly shown in the halftone, Fig. 4, is of sufficient width to allow a torch to be applied to the screw, and as soon as the latter is warmed it may be readily removed with a screwdriver applied in the usual manner.

The jaws are made of 5/8x9/16-inch steel and the gage bodies are 5/8 inch thick, thus leaving 1/16 inch clearance between the two sets of jaws where they overlap in this double-end construction. The gage jaws and bodies are case-hardened deeply, accurately ground and lapped on their contacting surfaces and the jaws of different classes of gages in addition to being stamped are enameled in various colors to indicate their character and so facilitate identification.

Gage Sizes

As illustrated in the group, Fig. 4, there are six of these double-end limit gages, four plug limit gages and one straight plug gage, for the one size of ball bearing "No. 308," included in this engraving. Of the three large snap gages shown, one is for gaging the outer ball race or ring while turning roughly to diameter; one for gaging for the rough-grinding of the same surface; one for the final or finish-grinding size. The smaller end of the turning gage in this case measures 3.578 inches between the jaws, and the large end 3.581 inches. The gage for the rough-grinding size measures between its two pairs of jaws 3.558 and 3.563 inches, respectively. The finish-grinding gage measures 3.5429 and 3.5433 inches. The

FIG. 3. SOME HESS-BRIGHT LIMIT SNAP GAGES

gage sizes are maintained closely by constant examination and careful tests; the tolerances allowed in the finish gage being plus or minus 0.00005 inch; in the rough-grinding gage plus or minus 0.0001 inch; in the roughing gage plus or minus 0.0002 inch.

The two small snap gages in the foreground of Fig. 4 are for testing the width of the outer and inner races, one being used on the work as roughed out to thickness, the other for gaging the work as finished by grinding. The slightly larger snap gage to the right and rear of the group is for gaging the cylindrical exterior of the inner race.

Upon referring again to Fig. 3 it will be seen that the larger of the gages there shown (which range up to about 10 inches between jaws) are provided with short binding bolts for the jaws, the gage bodies being cut away to leave merely a lug at either side for the holding bolts to pass through. This construction is, of course, better adapted to these large gages than the single through-bolt arrangement, which is used in the smaller sizes.

Testing Fixture for Inner Races

While the outer and inner races of the ball bearings, as manufactured, are held as closely as possible to size by means of the gages illustrated, they are still further tested in special fixtures by the aid of which a higher degree of refinement is attained than could be reached with the gages alone. To insure interchangeability of the bearings on shafts and in boxes, the bore of the inner race and the outside diameter of the outer race are held to within 0.0002 inch of standard size. They must not taper over 0.0001 inch per inch of width, and it is obvious that solid gages are out of the question for the final inspection processes. So a number of special indicating appliances have been developed through which every race is ultimately passed for inspection. After assembling the bearing as a unit is tested for running accuracy in still another fixture.

The testing fixture for the inner races is illustrated clearly in Figs. 5 and 6. This device will be seen in Fig. 1, at the right-hand end of the bench. With a plug gage it is an impossibility to estimate correctly the amount by which a hole may taper, and if the bore happens to be slightly out of round the plug may still enter with apparently the same degree of nicety, as if the hole were truly cylindrical. The gage in Figs. 5 and 6 measures on the three-point principle enabling any surface irregularities to be discovered readily and, as the race is tested from both sides in this fixture any taper in the bore is located immediately.

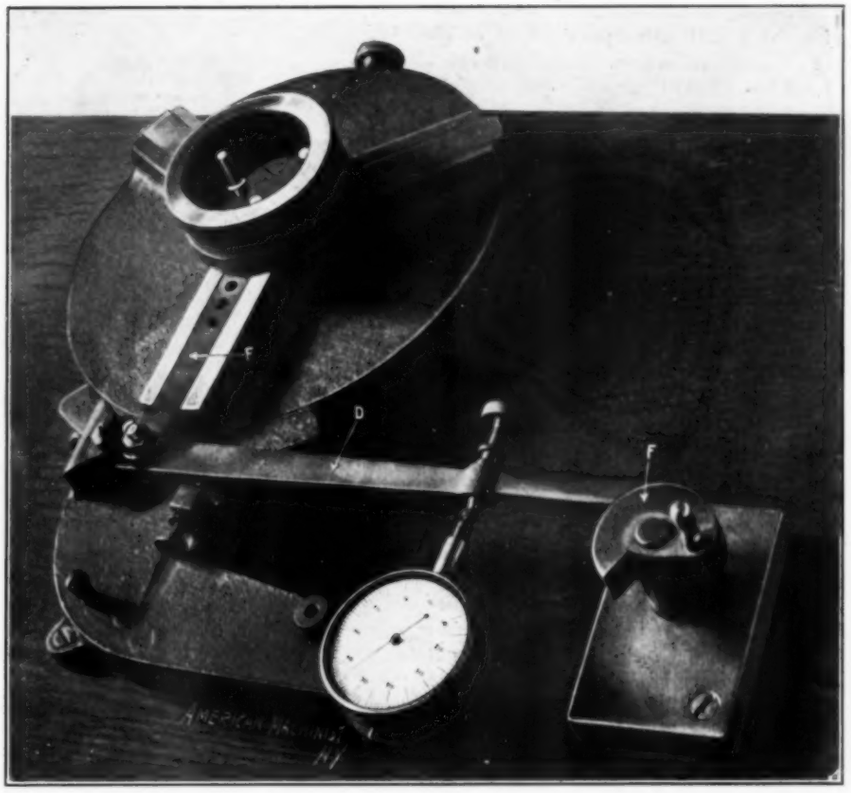


FIG. 5. TEST FIXTURE FOR BORE OF INNER RACES

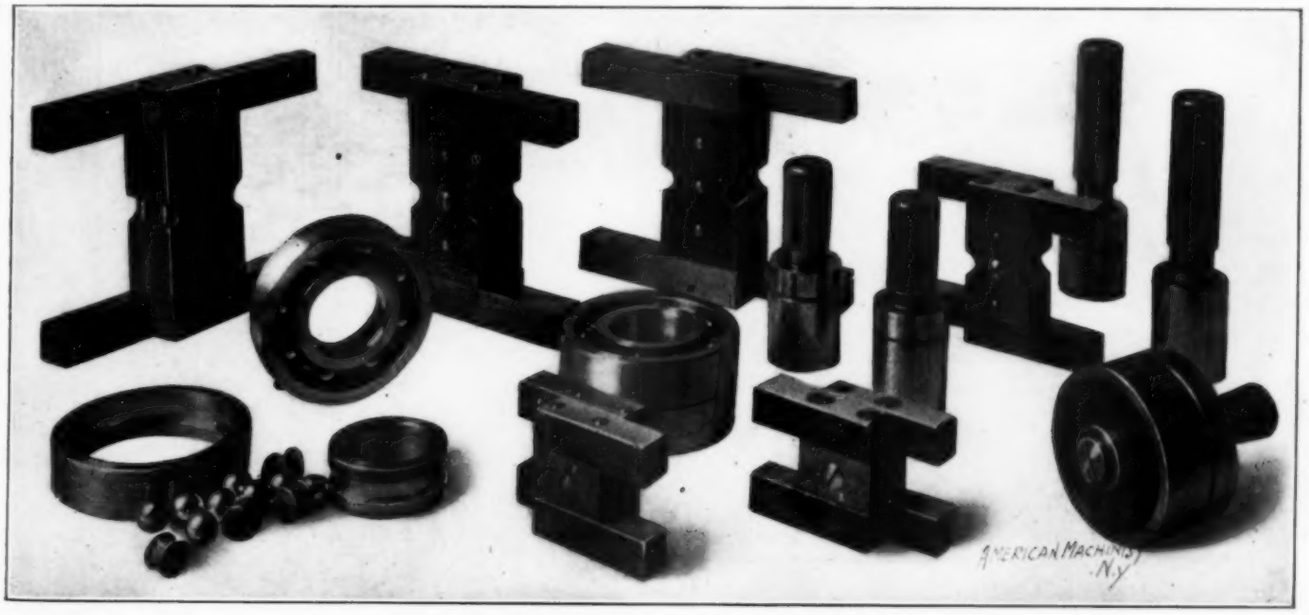


FIG. 4. COMPLETE SET OF GAGES FOR ONE SIZE OF BALL BEARING

The body of the fixture is in the form of a chuck with three jaws, all of which are provided with a series of taper holes to receive a small hardened pin or plug, like *A* and *B*, Fig. 6. The three plugs are brought in contact with the inside of the work when the jaws are adjusted outwardly. The two upper jaws are operated by means of nurled knob *C*, Fig. 6, which rotates a disk in which there are two cam slots engaging with rolls carried on studs projecting from the under side of the two jaws. The third jaw is attached to the horizontal lever *D*, which has near its right-hand end a nurled head screw, whose point is brought into contact with the plunger of a Brown & Sharpe dial test indicator when the cam *E*, Fig. 5, is turned to permit lever *D* to drop. A spring which is not shown in Fig. 5 tends to hold the lever *D* down with the end of its handle resting on the periphery of the cam and as the latter is rotated by the hand the lever *D* drops as far as permitted by jaw *E*, the outward movement of this jaw being controlled by the pin *B* coming in contact with the bore of the inner race, which is being tested. In testing a lot of races the work is slipped over the plugs in the jaws with the left hand and the cam *E* is turned by the right hand to clear the lever *D*, which then drops with jaw *F* until its plug *B* comes into contact with the internal wall of the race. The indicator dial is then turned to bring the zero line under the pointer to facilitate further readings, the cam is turned to lift the lever *D* and jaw *F*, the ball race is rotated, say a quarter turn, and the cam revolved to permit the lever and jaw *F* to drop again. The indicator reading is then noted and the foregoing procedure repeated to test the race on another quarter of the bore and so on until comparisons have been made on at least four points. The ball race is then turned

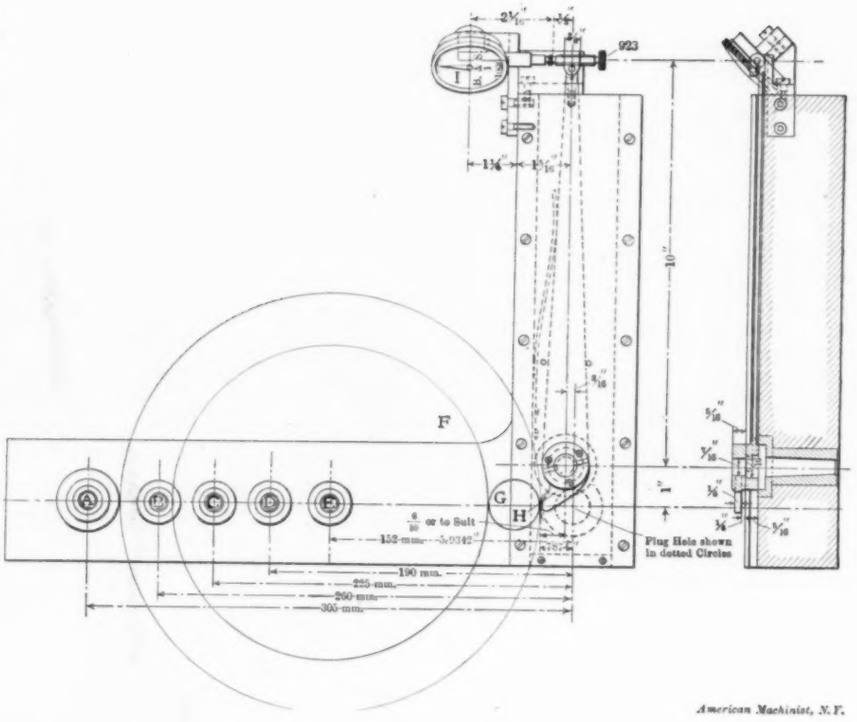


FIG. 7. TEST GAGE FOR OUTER RACES

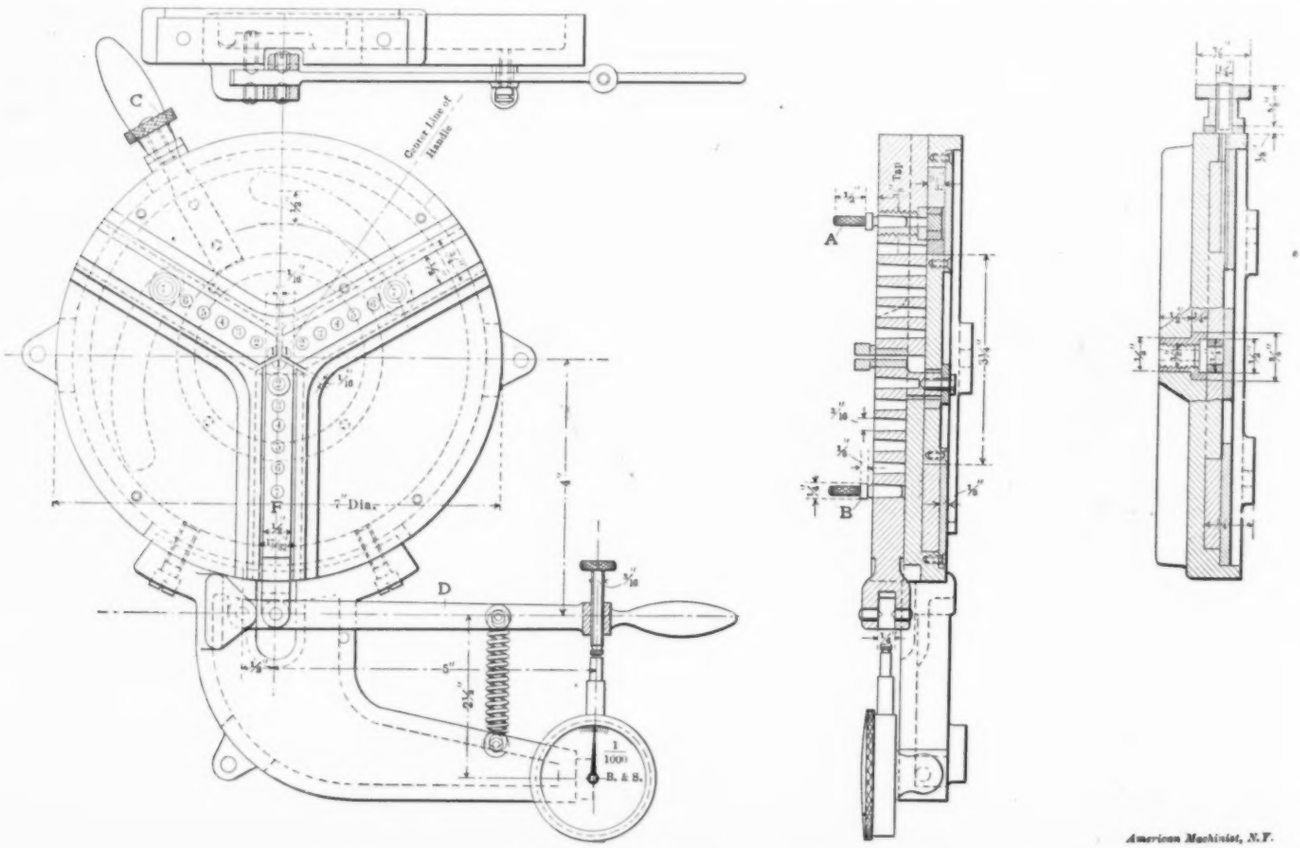


FIG. 6. CONSTRUCTION OF FIXTURE FOR TESTING BORE OF INNER RACES

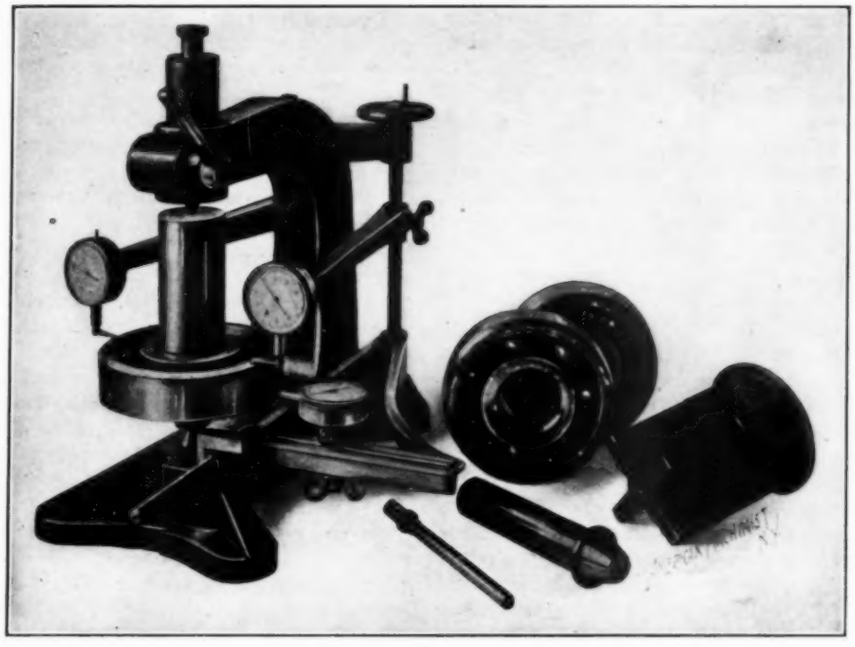


FIG. 8. TEST FIXTURE FOR ASSEMBLED BEARINGS

over on the other face and the other end of the bore tested in the same manner. The lever *D*, when in contact with the indicator plunger, multiplies any movement of jaw *F* ten times, and thus the dial graduations by which the plunger movements are read directly to 0.001 inch actually show movement of the jaw *F* to 0.0001 inch. The device is operated readily and it takes but a few seconds to test the bore of the race.

Gaging Outer Ball Races

Near the center of the bench in Fig. 1, flush with the surface, will be noticed another testing device with a dial gage at the rear end. This is shown more clearly in the line drawing, Fig. 7. It is designed to facilitate the operation of inspecting outer ball races, and forms a convenient means of testing these parts for both accuracy of external diameter and straightness of surface. Just as the device in Figs. 5 and 6 enables the bore of the inner race to be gaged more truthfully than would be possible with plugs alone, so the special instrument in Fig. 7 adds a refinement to the process of inspecting outer races which is not attainable with snap gages, micrometers, or other external calipering instruments of the ordinary types. This test is made after the ball bearing has been assembled, the exterior of the outer race being ground with the balls and inner race in place so that the periphery of the bearing shall be true with the bore.

The testing gage, Fig. 7, consists of a base in which there is a series of holes, *A*, *B*, *C*, *D*, *E*, in any one of which a plug may be placed for receiving a disk *F*. There are a set of these disks, one for each size of ball race and in Fig. 1 they are shown supported on pegs driven into the wall behind the bench. Each disk is ground true on the periphery and the diameter is such that when the disk is mounted on a plug placed in the proper hole, *A*, *B*, *C*, *D* or *E*, and the ball race is rolled against the edge, as at *G*, the opposite edge of the work will be pressed against the short end of the indicator arm

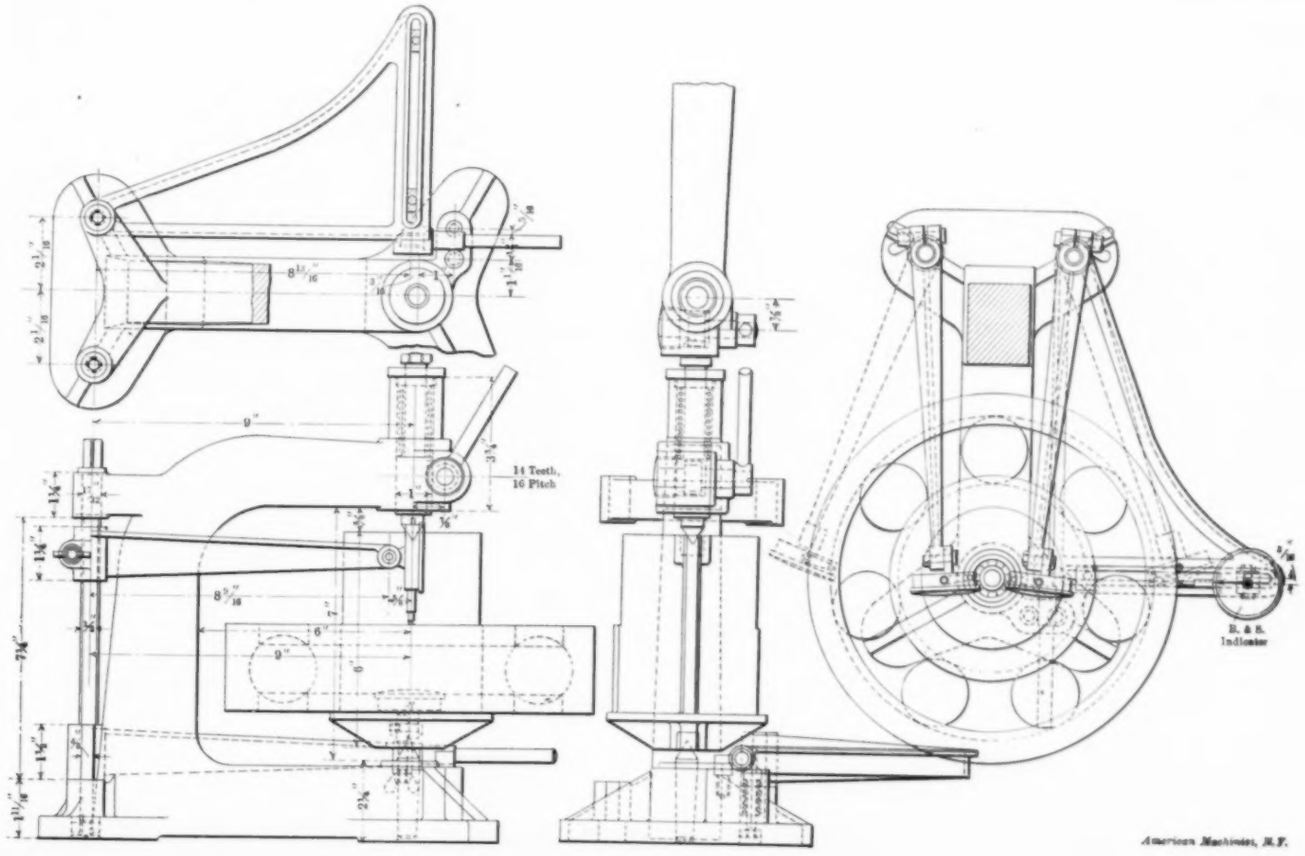


FIG. 9. TEST FIXTURE FOR ASSEMBLED BEARINGS

H, which, in turn, acts upon the plunger of the dial test gage *I*. Here again the indicator arm has a multiplying power of ten and each space between graduations on the dial is, therefore, equivalent to 0.0001 inch on the diameter of the ball race. The work is passed through between the disk *F* and the indicator arm several times, bringing a different portion of the work circumference into contact with the disk and indicator and noting the dial readings at each pass; then the work is turned over on the other face and tested in the same way so that any taper in the piece is discovered at once. The test disks (like the indicator heel) are thin at the edges so as to bear only near the edge of the ball race; but they are so large in diameter that they remain accurate for a long time, as the work is constantly being brought against a fresh portion of the disk periphery.

Testing the Bearing for Running Truth

One of the most interesting of the special testing devices in this department is the one shown in Figs. 8 and 9, which also is seen near the left end of the bench, in Fig. 1. This instrument is used for testing the assembled bearing for running truth and end play and is fitted with three dial test gages or indicators, two of which may be brought into contact at opposite points with the face of the external race, while the third is applied to the periphery. The bearing is mounted on an arbor ground true on centers and the latter is placed in vertical position between the centers of the fixture. The supporting arms for the test indicators above the bearing are mounted on elevating screws at the rear by means of which such vertical adjustment as may be required is readily obtained, while the third indicator is adjustably attached to a swinging arm, which may be locked in working position by a spring detent as illustrated, or swung back far enough to clear the bearing while it is being placed between centers or removed. With this device, using the indicator at the right, the outer race may be tested while spinning it and the balls around the inner race, which is held stationary; or the outer race may be held from turning, while the inner race and balls are revolved inside it; thus inaccuracy in the running of either race is readily detected. In this test, on say the "308" size, which is practically 3½ inches outside diameter, both races must be run true to within 0.0002 inch in order to pass inspection.

The two indicators above the bearing are used to determine the amount of end play in the bearing. This radial type of bearing is made with ball grooves of slightly larger radius than the balls, so that the latter bear theoretically at the center of the grooves and a certain amount of end play is allowed between the outer and inner races. In the case of the "308" size referred to already, this end shake should not be over 0.006 inch in bearings intended for close slip fits; more end play is needed for bearings assembled on the shaft with free fits. The test for this movement is readily performed by setting the extension arms on the two upper indicator plungers against the face of the outer race and then pressing the race up as far as the balls permit, the two pointers showing at once if the prescribed allowance is obtained or exceeded.

Several different types of arbor used with this testing fixture are shown in Fig. 8. The arbors for the large sizes of bearings are of skeleton form with four ribs or vanes which lighten the arbor, yet which provide bearing surfaces for the work. The arbors in all cases are ground perfectly true and are a nice fit in the bore of the inner race. The upper center of the pair between which they are held in the testing fixture is spring controlled, as represented in Fig. 9, which shows various features of construction not brought out in the halftone, Fig. 8.

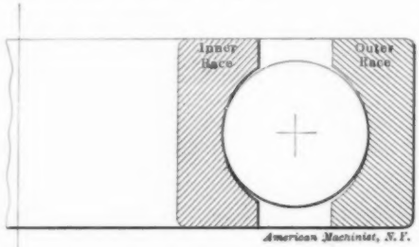


FIG. 10. SECTION OF BALL BEARING

In this drawing, as will be noticed, the indicator arms are sketched in as adjusted for both small and large bearings, thus giving a good idea of the range of the fixture, and enough dimensions are retained on the drawing to show the general proportions.

Ball-groove Gages

In Fig. 10 is shown a section of a radial bearing illustrating the clearance given in the ball grooves at the sides of the balls. The groove radius is made 4 per cent. larger than the radius of the ball; thus, in the case of a 1-inch ball the radius of the groove would be 0.520 inch, or for a ½-inch ball 0.260 inch. A set of gages for the grooves will be seen in Fig. 1, suspended on a board behind the testing fixture at the left-hand end of the bench. These gages are circular templets finished to a knife edge and each provided with a handle so that it may be conveniently placed in the ball groove for testing the accuracy of the outline of the latter.

In a paper recently read before the Boston Society of Arts it was pointed out that rusting of iron cannot continue in the absence of oxygen, and that, therefore, boiler steel or tubing corrosion can be prevented by removing the air from the feed water.

Twist Drills and Their Tangs

By F. A. Halsey

My repeated harkings back to my shop days, which are now more years behind me than I like to count, may seem like the telling of old stories. It is, however, true that not all the good things were first done yesterday and it is equally true that some of the good things developed many years ago have not met the recognition nor come into the extended use that they deserve.

The numerous recent devices for saving twist drills which have had their tangs twisted off might be interpreted as indicating that this is a new problem in the machine shop, but the older readers of the American Machinist know that these tangs have been twisting off since twist drills were first made.

The curious thing about it is that an entirely satisfactory method of meeting this difficulty was devised many years ago and has been in constant, though limited, use ever since. It is, moreover, so simple and obvious that it is a constant surprise to those who are acquainted with it that it did not long ago become universal.

The method first came to my knowledge nearly 20 years ago, at which time I put it into use. It originated at the works of William Sellers & Co., where it has long been regularly followed, and I can assure the readers of the American Machinist that if they will adopt it, twist-drill tang troubles will become a thing of the past.

The method is nothing more than the insertion of a key in the socket and the milling of a keyway in the shank of the drill. The sockets once fitted up, it is only necessary when buying a new lot of drills to put them in the milling machine and mill the keyways. The drills are then used precisely as in the usual way, the driving being by the key instead of tang.

The accompanying illustration and tables have been very kindly supplied by William Sellers & Co., and give the proportions used by them. The blueprint from which this engraving has been prepared bears the date of October 7, 1880, which is enough to show that the plan has been tried out and found successful. It will be observed that the print calls for the Sellers taper of ¾ inch per foot and other features of their practice, which have no connection with the point under discussion.

As regards the fitting of the key to the socket, William Sellers & Co. say: "In fitting the keys to the drill sockets, it is our practice to drill a small hole through the socket at the inside end of the keyseat, then to plane the keyseat into the hole, making it about 50 per cent. deeper than the normal depth for keys of that size. The key is then fitted into the keyseat snugly, and the hole plugged up. We have no trouble from loose keys when they are made in this way."

Pitch of Spiral Groove	3.70"	3.70"	3.70"	3.70"	5.32"
Total Length	6⅝"	6⅝"	7"	7⅛"	8"
Length of Shank	2¼"	"	"	"	"
Length of Body	4⅛"	4⅜"	4⅝"	5⅛"	5⅜"
Shank	⅜"	"	"	"	"
Size of Drill	3/64"	5/64"	3/32"	7/64"	⅛"

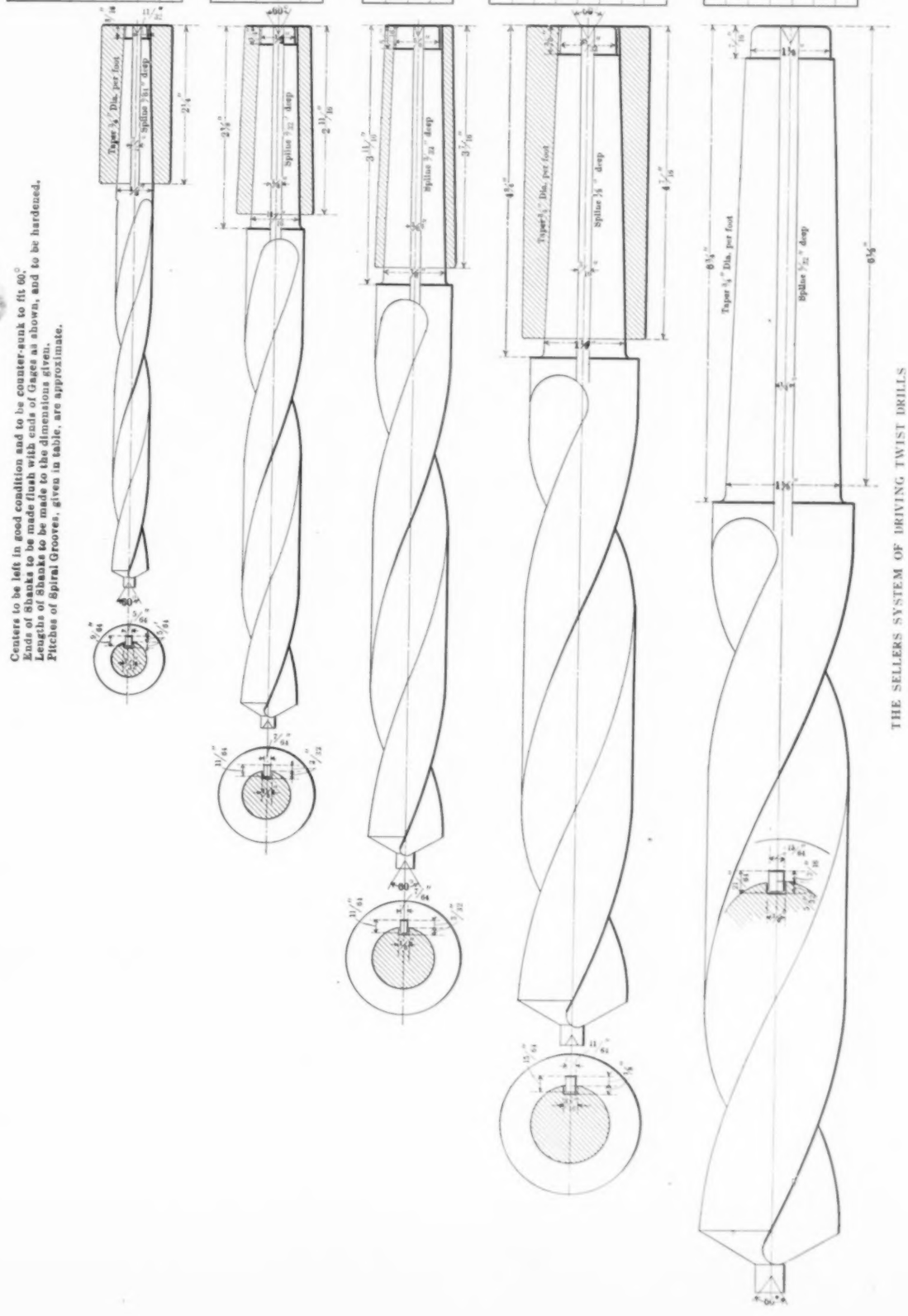
Pitch of Spiral Groove	5.32"	5.32"	6.24"	6.24"	6.24"
Total Length	9"	9½"	9⅝"	10"	10"
Length of Shank	2⅝"	"	"	"	"
Length of Body	6⅜"	6⅝"	6⅞"	7¼"	7⅜"
Shank	11/32"	"	"	"	"
Size of Drill	9/64"	5/32"	11/64"	3/16"	13/64"

Pitch of Spiral Groove	7.28"	7.28"	9.50"	9.50"
Total Length	11⅜"	11⅜"	12"	12"
Length of Shank	3⅛"	"	"	"
Length of Body	8"	8"	8⅝"	8⅝"
Shank	⅜"	"	"	"
Size of Drill	13/64"	7/32"	1"	1 1/32"

Pitch of Spiral Groove	9.50"	9.50"	9.50"	9.50"	9.50"	9.50"	9.50"
Total Length	12⅜"	12⅜"	13⅜"	13⅜"	14"	14"	14⅜"	14⅜"
Length of Shank	4⅜"	"	"	"	"	"	"	"
Length of Body	9"	9"	9"	9⅜"	9⅜"	10"	10"	10"
Shank	1⅜"	"	"	"	"	"	"	"
Size of Drill	7/16"	15/32"	1/2"	17/32"	9/16"	19/32"	5/8"	21/32"

Pitch of Spiral Groove	13.72"	13.72"	13.72"	13.72"	13.72"	13.72"	13.72"	13.72"
Total Length	16⅝"	16⅝"	17"	17"	17⅜"	17⅜"	18"	18"
Length of Shank	6⅝"	"	"	"	"	"	"	"
Length of Body	10"	10"	10⅜"	10⅜"	11"	11"	11⅜"	11⅜"
Shank	1⅝"	"	"	"	"	"	"	"
Size of Drill	11/16"	3/4"	13/16"	7/8"	15/16"	1"	1 1/16"	1 1/8"

American Machinist, N.Y.



Centers to be left in good condition and to be counter-sunk to fit 60°.
Ends of Shanks to be made flush with ends of Gages as shown, and to be hardened.
Lengths of Shanks to be made to the dimensions given.
Pitches of Spiral Grooves, given in table, are approximate.

THE SELLERS SYSTEM OF DRIVING TWIST DRILLS

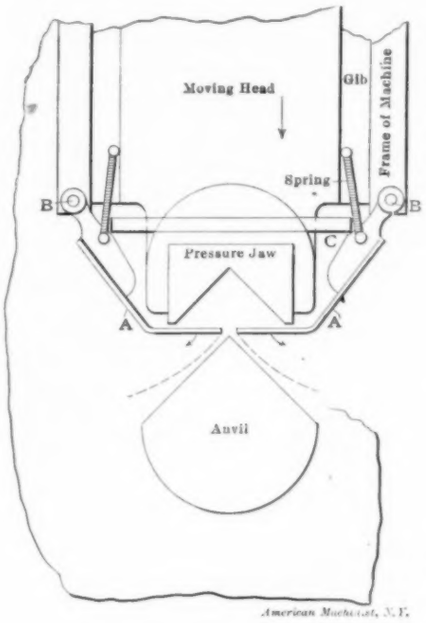
Practical Letters from Our Readers

A Round Table Discussing Details of Modern Machine-shop and Drawing-office Methods, Practice and Economy

WE PAY FOR USEFUL IDEAS

Safeguards on Rapid Acting Machinery

Several effective devices for preventing the crushing of fingers of press operators have been illustrated recently, but of those shown none have been so simple and effective as the finger guard that has been used for some years on a machine



SAFETY DEVICE ON A BOX PRESS

in the paper-box industry, known as a "stayer."

On this machine the box corners are completed or reinforced; the operator places on the anvil (or solid support) the two sides which form the corner. These must be held in position while the machine feeds forward a strip of cloth or paper with a moist surface, cuts it off at the right length, and with a powerful squeeze forces it firmly along the sides, thus forming the substantial corner of a modern box.

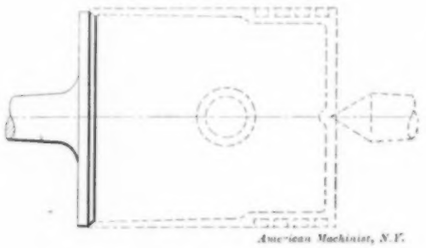
The machine will stop automatically at the end of each stroke if desired, or will run continuously, in which case the operator must whirl the box rapidly and accurately from corner to corner during the up stroke. As the normal speed is 60 complete strokes per minute, it is evident that the operator can give little thought to keeping his finger safe, but with this device accidents are practically unknown. In Fig. 1 the sheet-metal guards *A* hinged at *B* will just clear the anvil as they swing down and out. A pin *C* in the moving head actuates these guards in advance of the descending pressure jaw, and any fingers in the danger zone will be forced to a safe position; the guard returns to position as the head moves up.

This device allows the operator full use of both hands at all times, and the most expert operator known to the trade runs his machine at 173 revolutions per minute, which is about 40 boxes per minute, each one of which must be picked up, placed on the anvil, turned three times and tossed aside. If one stroke is missed the machine must stop to clean off the anvil as the sticky material would be pressed against it.

Rochester, N. Y. RALPH H. DAVIS.

Grinding Automobile Motor Pistons

The accompanying sketch will show the manner in which automobile motor pistons can be ground, with very little expense for fixtures. The rig consists of an arbor made of machine steel with a long taper at one end, ground to fit the taper hole in the driving spindle of the grinding machine, while at the other end of the arbor is a flange, the diameter of which will vary according to the size of piston to be ground. This flange has a short taper ground on the outside of it at an angle of 30 degrees. This angle I found to be perfectly satisfactory for driving purposes.



PISTON GRINDING RIG

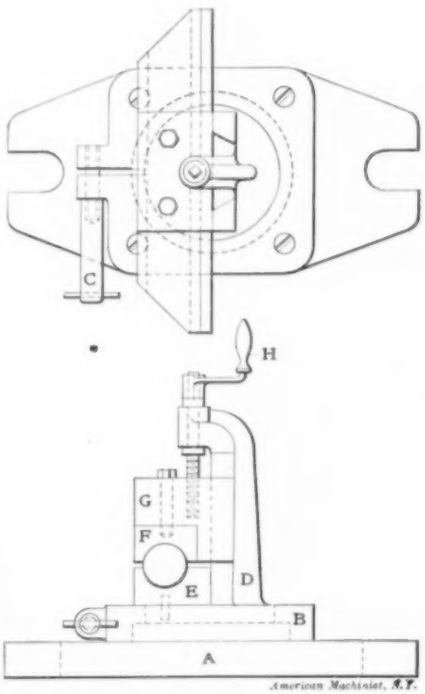
At the open end of the piston at the inside edge is turned a short bevel at an angle of 30 degrees, which is to fit the taper on the arbor. The bevel in the piston must, of course, be turned true with the outside of the piston. The piston is then set up against this arbor with the back center of the machine, this center having a spring behind it.

I used this particular rig on a Brown & Sharpe No. 3 universal grinding machine, which has a strong spring behind the back center, the pressure of which is ample for driving the piston without any slip. This makes a very cheap and simple rig and at the same time answers the purpose. I have ground pistons up to 8 inches in diameter in this way.

Cleveland, Ohio. A. W. RITTEY.

A Sawing Jig for the Milling Machine

Having a large number of pieces of steel of various shapes to cut to different angles I devised the following fixture to hold them: It consists of a base plate *A*, to which is screwed the clamp ring *B*. The head *D* swivels in *B* and can be clamped at any desired angle by the clamp screw *C*. The movable jaw *G* is dovetailed to *D*, and is moved to clamp the work by the handle *H*.



SAWING JIG FOR MILLING MACHINE

Jaws of different shapes to suit different sections of steel can be quickly applied, as the lower jaw *E* is simply dropped over two dowel pins and the upper jaw *F* is held by two cap screws.

Philadelphia, Penn. W. ALTON.

Foremanship Courses and the Qualities Needed by the Embryo Engineer

Occasionally I get a letter from one of my friends that seems to indicate that I am not altogether alone in feeling that we are not all of us getting into the right jobs. I have one here from a young man, about 25, who has been through high school, served an apprenticeship of four years and now after two or three years out of his time is looking with longing eyes at a $3000 job. Now that is a good symptom, but just because he wants it is no sign that he will get it. On the other hand he surely would never get it if he did not want it.

We say $3000 glibly enough and alongside of the $50,000 jobs that we read about it seems pretty small, but when a man is earning $12 a week and thinks the $3000 is $10 a day it rather takes his breath away. How can a man possibly earn $10 in a day? Most of those chaps apparently make a short day too. You cannot possibly imagine a man making $10 in 10 hours chucking pulleys at piece rates. He would have to be a sleight-of-hand artist to do it. If he had a hundred men chucking pulleys he would only have to get each and every man to do one cent's worth more work per hour and then not pay him for it, to make his $3000. There probably is not a reader of this paper who would not call that an easy job at first sight, especially if he has chucked pulleys by the hour himself. On second sight, and with a few years' experience trying to save that cent an hour without losing two cents somewhere else, the chances are the reader will believe that his $3000 is well earned.

What I want to arrive at is that a $3000 job means something more than ability to do work. It means ability to plan someone else's work, and to get him to do it. That is something that is not taught in any school any more than it is in a shop.

Foremanship Courses of the Lowell Institute

I did run across something of this kind attempted at the Lowell Institute the other day. They are trying to educate young men, more especially mill hands, to be foremen. They have graduated some young men who are now stated to be earning on the average some 70 per cent. more money than before entering the school. It is too early to say just how much of a success this school might be to young men who have $3000 yearnings, but I was led to look into the thing more carefully because of having this boy's letter in my pocket. This school is an evening school occupying the buildings of the Massachusetts Institute of Technology, and drawing its teaching force from the faculty of that school. Its courses appear to be abbreviations of courses given to the regular candidates for degrees. In mechanics, with which I am a trifle more familiar than some other courses, the problems given in the evening classes are identical with those given in the day courses. I noticed, however, that the requirements for admission to the Lowell Institute are by no means as difficult as those for Technology, being only in arithmetic, elementary algebra, plane geometry and mechanical drawing. It is interesting to note that this lack of what is usually considered necessary preparation has not entirely prevented graduates from benefiting by the work.

The work is supposed to be practical in its nature as adapted to foremanship, but I noted one examination paper on "Practical Mathematics" where a problem was given to expand

$$(a^{\frac{1}{2}} - b^{-\frac{1}{2}} + a^{\frac{1}{3}} b^{-\frac{1}{3}} + 1)(a^{\frac{1}{2}} - b^{\frac{1}{3}}).$$

Now I have no doubt this was a portion of a very practical problem, possibly being the loading on the left-hand rear, lower corner of the right-hand, upper wing of an aëroplane, but standing alone it did not have that practical look that I had hoped to see. The rest of the paper was about the same.

I cannot help wondering just what the ultimate result of the coming together of shop men and professors here will be, just as I have wondered what the result will be at Cincinnati. I hope that it will be to the advantage of both. To the men from the shops because they do, whether rightly or not, look up to the college men as superior beings; the glamor of education is upon them. To the men from the schools because they may learn to know what knowledge has a money value to the man of limited mental capacity. I do expect to see, as this adjustment between the two proceeds, that the professor will become a more useful citizen because he cannot help opening his eyes to the fact that most of the learning which he is now transmitting to his students has to be relearned by them in a modified form before they can use it. If he does learn this he will certainly have pride enough to find a way to improve. With nothing but "prep." school boys to deal with he never would find it out. He may also find out that technical education and lower-school education can be stripped of many of the subjects now considered essential before getting down to a point of reduced efficiency, as witness the entrance examinations of the Lowell Institute.

Why do Technical Schools Fail to Advertise?

There is another thing which one of my correspondents mentioned awhile ago. He did not want to take a correspondence-school course but he said he could not find out about technical schools because they did not advertise. It struck me that he was about right. Our technical friends do seem to be mortally afraid of printer's ink, and when they do spend a little money for it they put it in the least likely place for a boy to see who might be interested. Those who have had dealings with these schools realize that a letter of inquiry to any school or college will bring a complete catalog from which a pretty fair judgment of the place may be formed. It seems a little odd though that when a boy is almost leaning up against the walls of an educational institution he should write to a stranger 500 miles away to know where there was such a place; but I have even had that happen. I don't want to advertise the American Machinist too much but if I was running one of these schools I would advertise where technically inclined young men would be apt to read. The correspondence schools do, but as far as the advertising columns are concerned there may not be a technical school in the country, though I am credibly informed that there are several.

Some Essential Questions that Should be Answered

Now for my advice to men situated in this way, I should say, first, look yourselves over and see what there is to see. Do you like to work? can you apply your mind to a job and keep it there? Can you sit up until morning over a problem in mathematics and not lose interest in it? Do you make friends with your fellowmen when you want to? Can you keep your friends at bay when they would help you do yourself harm? Can you tell anyone what you want them to do so that they will go and do it the way you want it? All simple things; but do you fill the bill? If you do hunt up a technical school, don't expect too much of yourself for a few years after you graduate and you will probably land on your feet.

Do you prefer ease and comfort to work? Would you rather read a novel than study? Would you rather do a job as someone showed you, or find an easier and better way yourself? All right! the world needs you to do pack-horse duty and you will enjoy it better than trying to follow the other fellow's trail. Don't imagine that you can work hard for a few years and then enjoy a well-earned rest. If you work hard for the few years you will get the habit and you can never rest. If you begin by resting you will probably make money enough to get along somehow; probably happily, probably more happily than the man that just whizzed past you in his automobile; for he probably has a business on his hands very much like his machine; a few seconds of gazing off the road may bring him up against a stone wall. He envies you with nothing to worry about but money, and you envy him with no money troubles to worry about.

Springfield, Mass. Entropy.

Discussion of the Previous Question

Letters from Our Readers Showing How Many Men of Many Minds Look upon Various Subjects Opened up in Previous Numbers

WE PAY FOR THESE ALSO

Locating a Gear to Mesh with Three Given Gears

There appears at page 525 a request for a formula, giving a solution of the general case, for the diameter of a gear which will mesh with three given gears, the diameters of which are given as well as the distances between their centers. I have recently had occasion to solve a design in which this was one of the necessary steps and present the solution herewith.

Referring to Fig. 1, let A, B and C be the centers of three gears having pitch radii of a, b and c inches, respectively, and let $BC = x$ inches, $CA = y$ inches, $AB = z$ inches. Then, if the gears are all to turn in the same direction, there are two pitch circles which may be drawn to accomplish the result, as shown by the dotted circles. The large gear M will rotate the three gears A, B and C in the same direction with the driver, while the small gear L will turn them in the opposite direction. For the general dimensions as expressed above, the radii of these two circles are found by solving the quadratic equation,

$$r^3[\Sigma\, 2\, x^2\, y^2 - \Sigma\, x^4 - \Sigma\, 4\, x^2\, (a-b)\,(a-c)] +$$
$$2\, r\, [\Sigma\, a\, x^2\, (y^2 + z^2 - x^2) - \Sigma\, x^2\, (a-b)\,(a-c)\,(2\, a + b + c)] +$$
$$[\Sigma\, (a^2\, x^2 + b^2\, c^2)\,(y^2 + z^2 - x^2) - \Sigma\, a^4\, x^2 - x^2\, y^2\, z^2\,] = 0,$$

for the two values of r.

Probably your correspondent expected a simpler expression than this, but the above, I believe, is not capable of being reduced. When it is understood that each of the terms above, except the last, stands for an expression involving three terms, thus:

$$\Sigma\, 4\, x^2\,(a-b)\,(a-c) = 4\, x^2\,(a-b)\,(a-c) +$$
$$4\, y^2\,(b-c)\,(b-a) + 4\, z^2\,(c-a)\,(c-b).$$

the extent of the formula when fully written out may be appreciated. Care must be taken in using the equation to substitute the values as they appear on the figure; thus x is the length of side opposite the circle of radius a, etc.

The problem suggested is only one of eight different cases which may come up in such an arrangement of gears; for example, the gear A might be required to turn in the *opposite* direction from the gears B and C, and with this relation of gears A, B and C, A might be required to turn *with* the driver, or in the *opposite* direction from that of the driver. In other words, there may be drawn eight circles, tangent to the three given pitch circles, which give all possible combinations of these three gears with a fourth gear.

To determine the radius of the gear which will give A a rotation opposite in direction to that of B and C, we change the algebraic sign of a in the above equation after it has been fully written out. The resulting equation when solved gives two values of r, which are the radii of the two dotted circles L and R of Figs. 2 and 3. These figures illustrate two possible cases which may arise, depending upon the relative values of the radii of the gears and the distances between their centers.

Thus, in Fig. 2 the arrangement is such that by using gear L as a driver, A will rotate in the same direction as L, while B and C will turn in the opposite direction. By using gear R as a driver, A will rotate in the opposite direction to that of R while B and C will turn in the same direction. Of course, either of these drivers will require both internal and external teeth, constructed on pitch circles of the same diameter.

It is not always possible to attain the results arrived at in the preceding paragraph, as is illustrated in Fig. 3, in which the proportions are changed from that of Fig. 2 to bring the gears in a different relation with respect to the distances between their centers. Thus, in Fig. 3, if the line PQ tangent to the circles B and C intersects the circle A, the two values of r determined, give the dotted circles L and R.

This appears to show that in this case there are two ways of making A rotate in the same direction as the driver while B and C rotate in the opposite direction, and no way of making A turn in the opposite direction to the driver while B and C turn in the same direction. If the tangent line PQ is tangent to the circle A also, then the radius of pitch circle R becomes infinite and R is a rack. Of course the reasoning applied to circle A is also applicable to circle B or C.

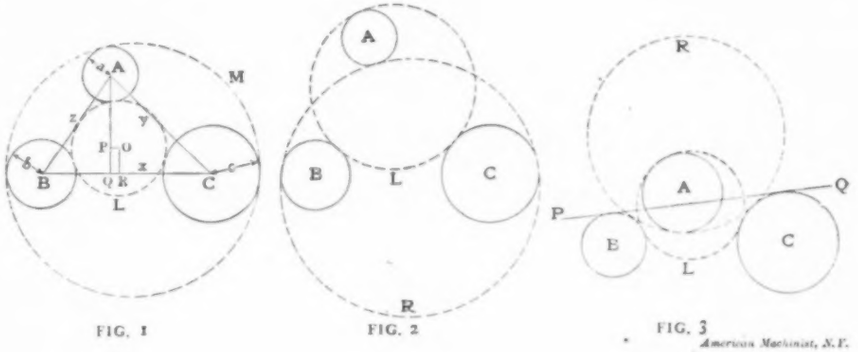


FIG. 1 FIG. 2 FIG. 3

American Machinist, N.Y.

DIAGRAMS ILLUSTRATING THE LOCATING OF A GEAR TO MESH WITH THREE GIVEN GEARS

The work of substituting in the formula would be quite laborious, and unless great care is taken there is a large chance for error. In my opinion, any cases which might arise for using the above formula would be more easily worked out individually, using the values of the actual case under consideration instead of the literal quantities expressed in the equation. This would not involve as much work and there is less chance for error. The method to be pursued is illustrated in the following problem, in which the determination of such a circle was one of the steps. The solution is given in considerable detail and in such form that the method may be applied to any case that presents itself by taking proper precautions with respect to the algebraic signs of the gear radii, as mentioned before.

The general equation given above is derived in exactly the same way as the special case here given. As the result depends upon a quadratic equation, two values of r are always found, the application of which may be determined by inspection.

An Illustrative Problem

Referring to Fig. 4, A, B and C are the centers of three gears of 8-diametral pitch,

having 80, 64 and 176 teeth, respectively. $AB = 13$ inches, $AC = 20$ inches, $BC = 21$ inches. It is required to drive each of the gears *singly* by a fourth gear. This gear is to be thrown into mesh by an eccentric in the same manner as is done on the back gear of a lathe.

Determine the eccentricity of the motion of this gear and the number of teeth it will have.

In Fig. 4 let $G\ H\ K$ be a small circle with center at O, the radius of this circle being the eccentricity of the motion of the center of the required gear. Then in throwing the driver into its various working positions its center will travel on this circle; F, D and E are the points of tangency of the pitch circles when in mesh by virtue of the center of the driving circle being at G, H and K, respectively. Draw OR and AQ perpendicular to the base BC, and OP parallel to the base.

Since the gears are 8-diametral pitch and the gear with center at A has 80 teeth, its pitch diameter is $\frac{80}{8} = 10$ inches and its pitch radius $AD = 5$ inches. Similarly for gear B pitch radius is one-half of $\frac{64}{8} = 4$ inches, and for gear C, one-half of $\frac{176}{8} = 11$ inches.

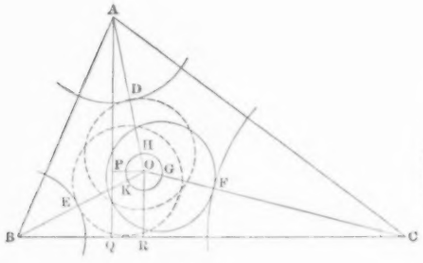


FIG. 4

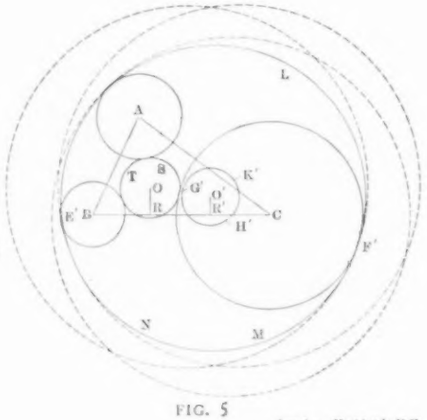


FIG. 5

American Machinist, N.Y.

DIAGRAMS ILLUSTRATING THE LOCATING OF A GEAR TO MESH WITH THREE GIVEN GEARS

In the three positions, G, H and K of the driving gear center, the driver is in mesh with a driven gear, so that GF, HD and KE are each equal to the pitch radius of the driver and, therefore, the distances OF, OD and OE are equal, each being the radius of the circle O plus the pitch radius of the driver. Let r represent each of these; then

$$OA = OD + DA = r + 5;$$
$$OB = OE + EB = r + 4;$$
$$OC = OF + FC = r + 11.$$

Also

$$AB = 13,\ AC = 20,\ BC = 21.$$

In the triangle ABC,

$$\overline{QC}^2 = \overline{AC}^2 - \overline{AQ}^2. \quad (1)$$
$$\overline{BQ}^2 = \overline{AB}^2 - \overline{AQ}^2. \quad (2)$$

Subtract (2) from (1) gives

$$\overline{QC}^2 - \overline{BQ}^2 = \overline{AC}^2 - \overline{AB}^2 = 400 - 169 = 231. \quad (3)$$

Base of triangle BC equals

$$QC + BQ = 21. \quad (4)$$

Divide (3) by (4)

$$QC - BQ = 11. \quad (5)$$

Adding (4) and (5) gives

$$2\,QC = 32, \quad \therefore\ QC = 16 \text{ and } BQ = 5.$$

$$AQ = \sqrt{AC^2 - QC^2} = \sqrt{400 - 256} = 12.$$

In the triangle OBC,

$$\overline{RC}^2 = \overline{OC}^2 - \overline{OR}^2. \quad (1)$$
$$\overline{RB}^2 = \overline{OB}^2 - \overline{OR}^2. \quad (2)$$

Subtracting (2) from (1) gives

$$\overline{RC}^2 - \overline{RB}^2 = \overline{OC}^2 - \overline{OB}^2 = (r+11)^2 - (r+4)^2 = 7\,(2r+15). \quad (3)$$

Base of triangle BC equals

$$RC + RB = 21. \quad (4)$$

Divide (3) by (4) giving

$$RC - RB = \frac{7\,(2r+15)}{21} = \frac{2r}{3} + 5. \quad (5)$$

Subtract (5) from (4)

$$2\,RB = 16 - \frac{2r}{3} \quad \therefore\ RB = 8 - \frac{r}{3}.$$

Now,

$$PO = QR = RB - BQ = 8 - \frac{r}{3} - 5 = 3 - \frac{r}{3},$$

$$OR = \sqrt{OB^2 - BR^2} = \sqrt{(r+4)^2 - \left(8 - \frac{r}{3}\right)^2} = \tfrac{2}{3}\sqrt{2r^2 + 30r - 108},$$

$$AP = AQ - PQ = AQ - OR = 12 - \tfrac{2}{3}\sqrt{2r^2 + 30r - 108}$$

$$\overline{AO}^2 = \overline{AP}^2 + \overline{PO}^2.$$

Substituting the derived values gives

$$(r+5)^2 = \left(12 - \tfrac{2}{3}\sqrt{2r^2 + 30r - 108}\right)^2 + \left(3 - \frac{r}{3}\right)^2.$$

Squaring the terms,

$$r^2 + 10r + 25 = 144 - 16\sqrt{2r^2 + 30r - 108} + \tfrac{4}{9}(2r^2 + 30r - 108) + 9 - 2r + \frac{r^2}{9}$$

$$\therefore\ 16\sqrt{2r^2 + 30r - 108} = \frac{4r}{3} + 80.$$

Multiply both sides by ¾

$$12\sqrt{2r^2 + 30r - 108} = r + 60.$$

Squaring both sides

$$288r^2 + 4320r - 15{,}552 = r^2 + 120r + 3600.$$

Transpose and ÷ 7,

$$41r^2 + 600r - 2736 = 0.$$

Solve for r,

$$r = \frac{-300 \pm \sqrt{(300)^2 + 41 \times 2736}}{41} = 3.65 \text{ or } -18.28.$$

The positive answer, 3.65 inches, applies to the case in which the gears rotate in the opposite direction from the driver and is the radius of the circle RST in Fig. 5. The center O of this circle is located by the values of BR and RO when $r = 3.65$. Thus

$$BR = 8 - \frac{r}{3} = 8 - \frac{3.65}{3} = 6.78 \text{ inches.}$$

$$RO = \sqrt{\left(r+4\right)^2 - \left(8 - \frac{r}{3}\right)^2} =$$

$$\sqrt{(7.65)^2 - (6.78)^2} = 3.54 \text{ inches.}$$

which will locate point O.

If the driver and driven gears rotate in the same direction, the negative value of r, -18.28 is used. This is the radius of the circle $L\,M\,N$ of Fig. 5. The center of this circle O^1, is found in the same manner as O was located, but by using -18.28 for r, giving $BR^1 = 14.09$ inches and $R^1O^1 = 2.32$ inches.

The considerations determining the pitch diameter of the driver and the radius of the circle on which its center moves are, that the former shall be some multiple of ⅛ of an inch to give the gear an integral number of teeth and that the latter shall be large enough to throw the gears in mesh separately. Thus OF in Fig. $4 = 3.65$ inches and by making $GF = 2¾$ inches the driver will have 44 teeth and leave $OG = 0.9$ of an inch. The dotted circles of Fig. 4 show the working positions of the driver when its center is at H and K.

For the case of Fig. 5, gears rotating in same direction as driver, the radius of the circle O^1 on which the center of the driver moves is made equal to 3.72 inches $= O^1G^1$, and the radius of the gear G^1F^1 is 3.72 inches + 18.28 inches = 22 inches, which gives it 352 teeth. This, of course, would be an annular gear, and the pitch circle in its three working positions, when the center is at G^1, H^1 or K^1 is shown by the dotted circles of Fig. 5.

If the arrangement desired in this problem had been like that of Fig. 2, that is to rotate A in a direction opposite to that of gears B and C, the quadratic equation

above would take the form, by making 5 ($=a$) negative

$$(r-5)^2 = \left[12 - \tfrac{2}{3}\sqrt{2r^2+30r-108}\right]^2 + \left[3-\frac{r}{3}\right]^2,$$

which reduces to $2r^2+150r-1197=O$, from which $r=7.27$ or -82.27 inches.

These are the radii of the dotted circles shown in Fig. 2, and the driving gears would require both internal and external teeth. This arrangement would permit of having the teeth on gear A differ in pitch from that of gears B and C which must have the same pitch.

Derivation of Formula

For the benefit of those interested in mathematics the derivation of the general formula is as follows:

Referring to Fig. 4 and the literal dimensions quoted in a preceding paragraph,

(1) $\overline{AQ}^2+\overline{QC}^2=y^2$.

(2) $\overline{AQ}^2+\overline{QB}^2=z^2$.

Subtract (2) from (1) giving,

(3) $\overline{QC}^2-\overline{QB}^2=y^2-z^2$.

(4) $QC+QB=x$.

Divide (3) by (4),

(5) $QC-QB=\dfrac{y^2-z^2}{x}$.

Subtract (5) from (4) and divide by 2,

(6) $QB=\dfrac{x^2+z^2-y^2}{2x}$.

(7) $AQ=\sqrt{AB^2-QB^2}=\sqrt{z^2-\left(\dfrac{x^2+z^2-y^2}{2x}\right)^2}$.

(8) $\overline{OR}^2+\overline{RC}^2=(r+c)^2$.

(9) $\overline{OR}^2+\overline{RB}^2=(r+b)^2$.

Subtract (9) from (8)

(10) $\overline{RC}^2-\overline{RB}^2=(r+c)^2-(r+b)^2$.

(11) $RC+RB=x$.

Divide (10) by (11)

(12) $RC-RB=\dfrac{(r+c)^2-(r+b)^2}{x}$.

Subtract (12) from (11) and divide by 2,

(13) $RB=\dfrac{x^2+(r+b)^2-(r+c)^2}{2x}$.

$OR=\sqrt{BO^2-BR^2}=$

$$\sqrt{(r+b)^2-\left(\frac{x^2+(r+b)^2-(r+c)^2}{2x}\right)^2}.$$

$$OP=QR=BR-BQ=\frac{x^2+(r+b)^2-(r+c)^2}{2x}-\frac{x^2+z^2-y^2}{2x}.$$

$$AP=AQ-PQ=AQ-OR=\sqrt{z^2-\left(\frac{x^2+z^2-y^2}{2x}\right)^2}-\sqrt{(r+b)^2-\left(\frac{x^2+(r+b)^2-(r+c)^2}{2x}\right)^2}.$$

Since

$$AO^2=\overline{AP}^2+\overline{PO}^2,$$

we have on substituting the derived values

$$\begin{aligned}&2r\,[a\,x^2\,(y^2+z^2-x^2)+b\,y^2\,(z^2+x^2-y^2)+c\,z^2\,(x^2+y^2-z^2)-x^2\,(a-b)\,(a-c)\,(2a+b+c)-y^2\,(b-c)\,(b-a)\,(2b+c+a)-z^2\,(a-a)\,(c-b)\,(2c+a+b)]+\\&[a^2x^2\,(y^2+z^2-x^2)+b^2y^2\,(z^2+x^2-y^2)+c^2z^2\,(x^2+y^2-z^2)+a^2b^2\,(x^2+y^2-z^2)+b^2c^2\,(y^2+z^2-x^2)+c^2a^2\,(z^2+x^2-y^2)-a^4x^2-b^4y^2-c^4z^2-x^2y^2z^2]=O,\end{aligned}$$

which may be written in the abbreviated form first quoted.

$$(r+a)^2=\left[\sqrt{z^2-\left(\frac{x^2+z^2-y^2}{2x}\right)^2}-\sqrt{(r+b)^2-\left(\frac{x^2+(r+b)^2-(r+c)^2}{2x}\right)^2}\right]^2+\left[\frac{x^2+(r+b)^2-(r+c)^2}{2x}-\frac{x+z^2-y^2}{2x}\right]^2.$$

Squaring these terms, canceling and transposing gives

$$(r+a)^2-(r+b)^2+\frac{2\,[x^2+z^2-y^2]\,[x^2+(r+b)^2-(r+c)^2]}{4x^2}=-2\sqrt{\left[z^2-\left(\frac{x^2+z^2-y^2}{2x}\right)^2\right]\left[(r+b)^2-\left\{\frac{x^2+(r+b)^2-(r+c)^2}{2x}\right\}^2\right]}.$$

Square both sides of this equation, clear it of fractions and collect the coefficients of r^2 and $2r$, giving

$$\begin{aligned}r^2\,[&2x^2y^2+2y^2z^2+2z^2x^2-x^4-y^4-z^4-4x^2(a-b)(a-c)-4y^2(b-c)(b-a)-4z^2(c-a)(c-b)]+\\&(5)\quad QC-QB=\frac{y^2-z^2}{x}.\end{aligned}$$

Application of the Equation—The application of this equation to the problem which follows, in which $a=5$, $b=4$, $c=11$, $x=21$, $y=20$, $z=13$ is here given.

Coefficient of r^2,

$2\Sigma\,x^2y^2=2\,[21^2\cdot20^2+20^2\cdot13^2+13^2\cdot21^2]$	=	637,058
$-\Sigma\,x^4=-\,[21^4+20^4+13^4]$	= −	383,042
$-4\Sigma\,x^2(a-b)(a-c)=-4\,[21^2\cdot1\cdot(-6)+20^2(-7)(-1)+13^2\cdot6\cdot7]$	= −	29,008
Coefficient of r^2	=	225,008

Coefficient of $2r$:

$\Sigma\,a\,x^2\,(y^2+z^2-x^2)=5\cdot21^2\,(20^2+13^2-21^2)+4\cdot20^2(13^2+21^2-20^2)+11\cdot13^2\,(21^2+20^2-13^2)$	=	1,867,488
$-\Sigma\,x^2\,(a-b)\,(a-c)\,(2a+b+c)=-\,[21^2\,1\,(-6)\,25+20^2\,(-7)\,(-1)\,24+13^2\cdot6\cdot7\cdot31$	= −	221,088
Coefficient of $2r$	=	1,646,400

Constant term;

$\Sigma\,a^2x^2\,(y^2+z^2-x^2)=5^2\cdot21^2\,(20^2+13^2-21^2)+4^2\cdot20^2\,(13^2+21^2-20^2)+11^2\cdot13^2\,(21^2+20^2-13^2$	=	16,496,928
$\Sigma\,a^2b^2\,(x^2+y^2-z^2)=5^2\cdot4^2\,(21^2+20^2-13^2)+4^2\cdot11^2\,(20^2+13^2-21^2)+11^2\cdot5^2\,(13^2+21^2-20^2)$	=	1,151,858
$-\Sigma\,a^4x^2=-\,[5^4\cdot21^2+4^4\cdot20^2+11^4\cdot13^2]$	= −	2,852,354
$-x^2y^2z^2=21^2\cdot20^2\cdot13^2$	= −	29,811,600
Constant term	= −	15,015,168

This gives the equation,

$$225,008\,r^2+2\,(1,646,400)\,r-15,015,168=O,$$

which when divided through by 5488 reduces to

$$41\,r^2+600\,r-2736=O.$$

This is the same equation that is derived directly in the preceding problem.

Notre Dame, Ind. Wm. L. Benitz.

Transferring Holes

I recently had a job where the application of Mr. Davis' method of transferring holes, given on page 751, was made use of to advantage. I was replacing a patent headstock of a 24-inch Lodge & Shipley lathe with a new one in which the holes for the feed-changing lever had not been drilled. This was not an oversight on the part of the makers, however, as it is impossible to locate the holes accurately without having the other parts of the lathe at hand. The surface on which the holes were to be laid out was concave and somewhat at an angle with the axis of the hole in the lever carrying the locking pin. In order to lay out the holes accurately the lever was brought to a position which gave the gears the proper mesh; then a piece of cold-rolled stock, having the end cut off at about 45 degrees, thus giving a sharp edge for marking, was inserted in the lever, and being turned a time or two on the chalked surface of the casting, gave the outline for the hole to be drilled. The outline thus made, of course, is not a circle, but it gives accurately the line within which the drill must be kept.

Astoria, Oregon. W. Whitley.

Premium System in a Jobbing Shop

Referring to page 266 and the article on "Premium System in a Jobbing Shop," we are using the premium system for paying our machine-shop labor, and one thing has come up which we do not remember ever having heard discussed.

We have a number of automatic screw

machines and there are times when it is not possible to run more than one machine, and at other times the operators can run two or three machines at once. All the products which are gotten out on these screw machines have time limits established on them. What we should like to know is: what is the practice for paying premium work in these cases? It has occurred to us that it might be customary to pay the premium earned; that is, if a man earned a premium on each machine he would be paid two or three premiums. The only objection we can see to this is, that a man operating three machines could not make as much, of course, on each machine as he could by operating just one machine, for the reason that there would undoubtedly be tools on more than one machine requiring adjustment at the same time. We shall appreciate any information as to the prevailing practice in this respect.

Columbus, Ind. D. EHEISELLEN.

Method of Japanning Disks

W. B. Preston inquires for a quick way of japanning or lacquering round disks, on page 404. The cut shows one way of doing that class of work which I think will answer very well. It is not an expensive affair, and the output depends how fast a boy can handle the disks.

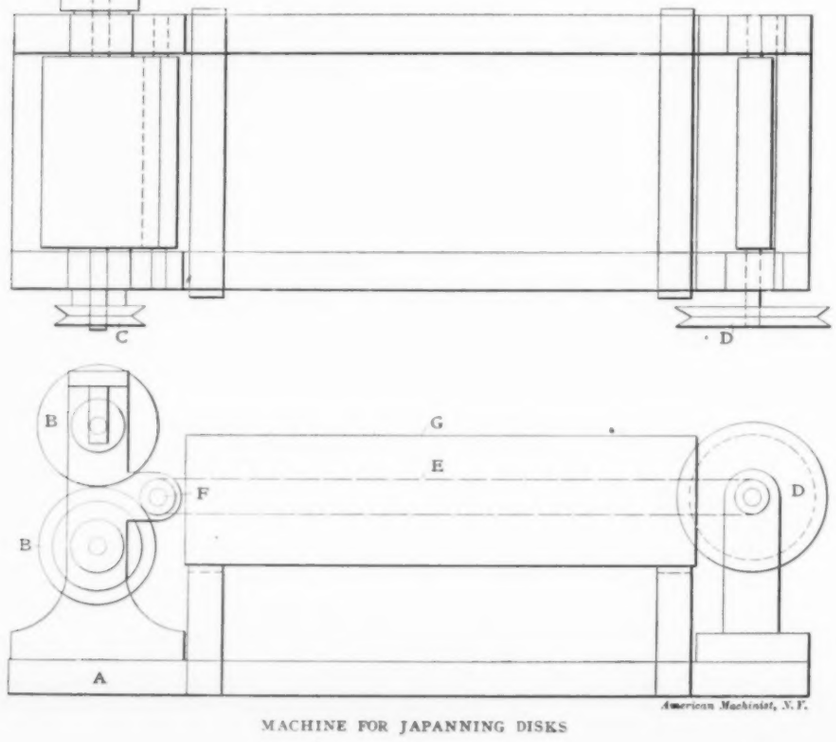
The frame *A* can be made of flat or angle iron about 18 inches wide and 8 or 10 feet long. On one end are mounted two brackets which are fitted with two wooden rollers *B* covered with rubber, say a piece of rubber tube slipped over these. They are geared together or driven with a chain and sprocket wheels. One spindle of the roller is left long enough for a tight and loose pulley for driving. A grooved pulley *C* is fitted on the other end of the spindle and it drives another roller *D* on the other end of the frame. This roller carries an endless band of canvas *E* which passes over an idler *F* which is fitted on the front brackets so as to just clear the two rubber rolls. A shallow tank is fitted under the rollers so that the bottom roller is always running into it. In front of the two rollers is fitted a sheet-iron table. On the frame at either end are fitted two iron bridges which carry a covered hood *G* the length of the frame minus the roller at either end. Inside the hood are fitted two gas pipes fitted with small burners when the japan has to be dried by heat. If the disks are to be air-dried a few nozzles are fitted instead of burners.

The hood is closed up completely except an opening at either end for the canvas carrier to pass. The whole rig can be made of wood except the hood, which should be of metal on account of the heat in drying.

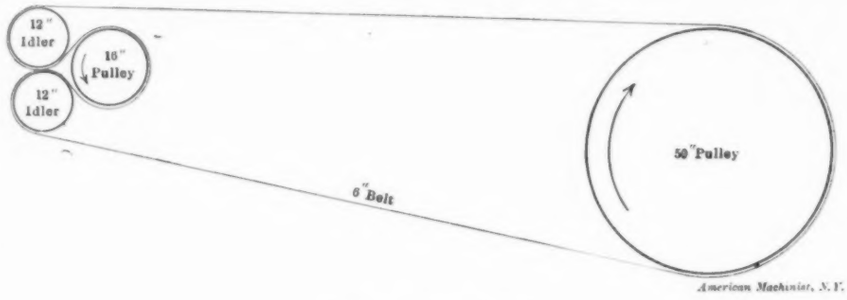
The blanks are dumped on the tray in front of the rolls and all a boy has to do is to push them between the rollers and they drop into a box at the other end. There is a quick-drying japan suitable for this purpose, and it does not require much heat. A good black can be made by mixing vegetable black, methylated spirits and a little shellac. There is a black on the market called dryole which dries very quickly.

London, E. C. C. PETITJEAN.

[We assume that the japan is put in the tank under the rolls although our correspondent does not say so. We imagine the japanned disks *might* stick to the canvas belt.—ED.]



MACHINE FOR JAPANNING DISKS



A BELT-DRIVE CHANGE

A Belt Drive Change

On page 751 Anthony describes a belt change drive for a planer. The change made as described and illustrated would not appeal to me. Imagine the added friction, the oil cost for lubricating, etc.; total this up for one year and then figure out how much could be saved by a little more studying up of the situation. The way I should have done the job would have been to take the tight and loose pulleys off and replace them with a friction pulley. Then to gain additional surface for the belt I would have placed two idler pulleys as shown in sketch. This would need only two timbers from the ceiling for both pulleys while Anthony must have had a veritable forest to hold up the necessary bearings and shipper. The shipper for the friction pulley would be only a straight handle suspended from a fulcrum. Advantage would again be had in not having to slide a 6-inch belt from pulley to pulley. For belt tightening (if necessary?) one of the idlers could be easily slotted.

GEORGE H. HANDLEY.

Newburg, N. Y.

July 1, 1909.

Current Practice in Steam Engine Design

Those of us who are attempting to show the young idea how to shoot are apt to look on an article like that of Mr. Trooien on page 654, "Current Practice in Steam Engine Design," with very varying feelings. Some of us are glad to see something to which we can turn as an authority on matters of detail design, and some of us are sorry to see engineering practice reduced to formulas. I belong to the latter class. While admitting that in the shop and in the routine of everyday work, the systematizing of design makes for lower cost of production, I regret to see the time come when what I believe to be engineering work is reduced to the same state, because such action is equivalent to a cessation of progress.

When engine builders, automobile manufacturers, or any other builders of machinery begin to draw together in their designs, so that essential differences are imperceptible and their products are only distinguishable by the color of the paint, or by inspection of name plates, then we have ceased to have proper opportunities for radical improvement, for at that stage no designer dares to change by more than slight percentages. The engine-lathe business shows just that. If a man today should deliberately put a spindle in an 18-inch lathe that was an inch larger in diameter than the average current practice he simply could not sell the tool, though his customers were using 30-inch lathes to do work of small diameter that his new 18-inch lathe would handle equally well.

Progress is impeded by the standardization of design still more because the period in years between the time when a technical student is studying and when he is practicing is short. A young man in school is today reading the article referred to. He is being taught the underlying principles of design and strength of materials. He sees in this article a short cut and also possibly a considerable variance from his results when computing sizes of parts from the principles which he has already learned. He sizes up the situation, and says to himself, "these fellows that are building engines know by years of experience what will do and what will not. Their results are different from what Professor So-and-So's method gives. He's an old fossil anyway, so what's the use of studying?" He little realizes that what he is getting is what he needs, basic principles. He does not realize that if there is a discrepancy between his theory and designers' practice it is up to him to find out why, and, if the theory is wrong, publish the facts and if the practice is wrong, publish that too, even if he realizes that this standardization that is going on makes changes in design improbable.

There are three ways of arriving at a suitable design, so far as strength is concerned. One is to jump in and design something that you know is stronger than is needed, and each succeeding year cut it down until occasionally one breaks; another is to design too light and increase the strength until only a few break; the other to take the thing and compute its strength, guess at and apply a suitable factor of safety and use the resulting size. The average of the first two methods applied to the third ought to be of some help in getting at a suitable factor of safety.

We have gone on through all the years on a cut-and-try method in our mechanical engineering. In the same time the civil engineer has outclassed us in the application of theory to structures, or rather in the finding of correct theories to apply to correct practice. Most of our knowledge of design has come from civil engineers. We are yet waiting for correct methods of predetermining designs for a large part of the problems which confront a designer. Take a square box like a condenser shell; how can you compute its strength, particularly if it is of cast iron? The sides are flat plates fixed at the edges, or partially so. The corners are bent beams. There is no theory to apply and there is no set of systematic experiments covering a large enough range to be of value to even derive an empirical formula. There is no better field for study and investigation than right here. The design of frames for punches is something on which much has been written and little known. Experiments on frames of any size are lacking.

Discussion of Some of the Factors

In looking over the article in question it struck me that there were a number of things wherein the author's method of approaching the problem might be improved. This was the case notably in regard to the piston rod and connecting rod, which were both considered as long columns, and Euler's formula was applied. Now Euler's formula as applied to a column of the proportion of any piston rod or connecting rod of any engine that I have seen of late will give values above the safe crushing strength of the material. In fact I have understood that that was the reason why Euler's formula was largely supplanted a half century ago by Rankine's formula. In the present case I assumed that I wanted to design a 10x10 high-speed engine, taking the figures at randon and because they are easy to use. Taking the author's formula I find the mean size of rod would be

$$d = 0.15\sqrt{10 \times 10} = 1\tfrac{1}{2}$$

inches, which I am assured by a friend of mine who once shook hands with a designer of engines, is not an unheard of size. Now applying Euler's formula to this piston rod on the basis of its length being 1.8 L, or 18 inches, we get:

$$P = \frac{\pi^2}{4}\,\frac{E\,I}{L^2} = \tfrac{10}{4} \cdot 30{,}000{,}000 \cdot$$

$$\tfrac{11}{7} \cdot (\tfrac{1}{4})^4 \cdot \tfrac{1}{4} \cdot \frac{1}{(18)^2},$$

which gives $P = 60{,}000$ roughly.

Now with a piston rod 1½ inches diameter it is going to be difficult to get over one square inch of cross-sectional area to resist the greatest tension which may come on the fastening which holds one end or the other. That one square inch will be full light enough to resist the shocks which may come upon it, if we consider that 125 pounds per square inch on a 10-inch piston is close to 10,000 pounds total pressure.

If I understand Euler's formula rightly this 60,000 pounds figured above is the force which, if the column is sprung out of a straight line, will keep it from returning to its original position, so that only a small factor of safety should be needed. It is a curious coincidence that this factor of safety should be 6 by both ways of getting at the result. That being the case, however, I would suggest that it would be simpler to begin with the strength of the fastenings on the rod and work up to the necessary size of the rod from that point of view. If you must have a formula then it would be simply $d = C\,D$ where C is a constant having values according to the boiler pressures carried.

In this connection I wish to say that I notice that some engine builders use somewhat different designs for engines which they expect to be used under high pressures from those which they use for low pressures, which in itself would leave the designer freedom to depart somewhat from the formulas laid down by Mr. Trooien.

In connection with the connecting rod the same appears to be true, taking the rod 25 inches long to give the author all the advantage possible, though he does not give us the relation between stroke and length of rod, I find that from his mean results the rod should be 1 inch by 2 inches in cross section. This gives a strength by Euler's formula of

$$P = \frac{\pi^2\,E\,I}{L^2_e} = \frac{4.10 \cdot 30{,}000{,}000}{625},$$

$$\frac{1.8}{12} = 320{,}000,$$

while the safe direct tension or compression is 32,000 pounds, the area being 2 square inches. The factor of safety if the ultimate strength of the material is taken at 65,000 and the pressure on the piston is 10,000 pounds is 13 instead of 60 as given.

The great variation in thickness of cylinder cover which the author found seems to justify the remark which I made above about the scarcity of reliable data or

theory on this subject. There appears to be small reason for making the head more than twice as thick for a high-speed engine as for a Corliss, when they both have the same cylinder dimensions.

Face of piston: It seems odd to have two formulas given as of equal worth when they cannot agree at but one point. $w = C D$, when $C = 0.4$; and $w = C D + B$, when $C = 0.32$ and $B = 1$ inch agree only when $D = 12\frac{1}{2}$ inches. In either case I should suppose that the designer would be guided more by his desire to get in his piston rings and have weight enough to get sufficient momentum to his reciprocating parts to get an even turning moment than by an empirical formula.

The final conclusion, that the weight of high-speed engines per horsepower has decreased nearly 30 per cent. in the last 10 years is so directly at variance from machine-tool practice that I cannot help but wonder if we are not overdoing machine-tool design. To be sure we are putting in metal to absorb vibrations, but if we could only find a way to prevent vibration starting there would be less need of absorbtion. Mr. Hartness has succeeded in producing some tools in which that condition is approximated without having to resort to the anvil principle, and I mistrust that some of the rest of us can, if we will, follow in that line with good results.

Boston, Mass. INSTRUCTOR.

Machine vs. Hand Work on Steel Stamps

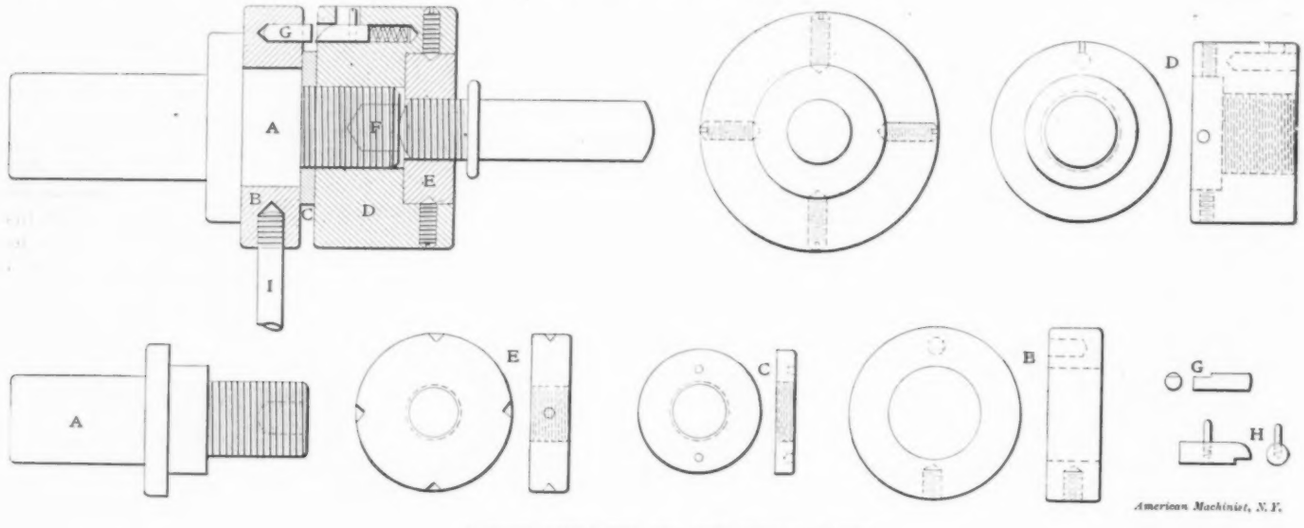
Replying to the letter of E. P. Noyes, on page 711, I should like to mention a few points concerning the cutting of stamps by machinery. First, as regards Mr. Noyes' statement that a cutter of less than 1/32 inch is not likely to stand up on tool steel. I have used cutters on tool steel for making rollers, with figures on them 0.035 inch high, for which the roughing cutter was less than 0.01 inch at the point. The finishing cutter was about 0.005 inch at the point. I don't think Mr. Noyes will object to a radius in the corners of 0.0025 inch. Of course, this does not mean that the corners are to the full depth with this radius. The cutters being about 40 to 60 degrees taper makes this impossible, but the actual penetrating portion of the punch can be made nice and sharp to a radius of less than 0.005 inch quite easily. Secondly, as regards the time, it has been possible to cut the figures in 5 minutes and an average time of 10 minutes a figure would be cheaper than hand work, as less skilful labor is required and the results would be much better, as the figures would be uniform in every respect. The machine I refer to is that made by the George Gorton Machine Company, Racine, Wis., under license.

C. A. COPPACK.

Leicester, England.

A Stud Extractor for the Turret Lathe

At page 623, A. Cooke shows a stud extractor for the turret lathe. I quite agree that he would be able to turn out more pieces per hour with his extractor than by the other method or rather lack of method, but it is possible to go one better. The use of his extractor involves the stopping of the machine to run the clamp on to the stud, tighten the carrier, and the stud being withdrawn, slack off the carrier and finally remove the stud from the extractor. It is obvious that much more time will be expended handling each stud than will be taken up by the actual machining. Much of this time can be saved by the use of the fixture shown herewith.



A STUD EXTRACTOR FOR THE TURRET LATHE

A is the main member, the shank being turned to suit one of the chucks, preferably the largest, to insure a good gripping surface. The opposite end is threaded with a fine thread and drilled to receive hardened steel plug *F*. *B* is made a nice running fit on *A*, drilled to take plug *G* and drilled and tapped for lever *I*. *C* is screwed hard up to the shoulder on *A* so that while allowing *B* to revolve freely it prevents end movement. *D* is threaded to run smoothly on *A*, is recessed for steel disk *E*, drilled and tapped for four headless screws and drilled and slotted to take pawl *H* and spiral spring. *E* is tapped to suit the stud to be threaded. A set of disks should be kept to take any size of stud required. The pawl *H* is fitted with a pin which moves along the slot in *D* and prevents rotation of *H*. Lever *I* is made to reach between the ways of the lathe.

The sketch shows the fixture with a stud inserted ready for threading. When the lathe is started up the lever *I* being between the ways, prevents *B* from rotating with the rest of the fixture and at each revolution the plug *G* strikes the inclined part of pawl *H* forcing it into the body of *D*, thus making *B* practically a free collar. The stud being threaded the machine is reversed and the spring having returned *H* to its former position the flat faces of *G* and *H* engage, thus running *D* off of *A* a short distance. The stud is now unlocked and may be seized by the hand and withdrawn. When inserting the next stud the member *D* will readily run back into the position shown. The end of the stud must lock against *F* and the shoulder be kept well away from *E* or the vise will have to be used. After a little practice one stud can be removed and the next one inserted almost as quickly as the lathe can be reversed backward and forward. All parts are made of mild steel and are case hardened except *E*, *F*, *G*, *H* which are hardened cast steel.

Gorton, England. R. STEPHENS.

Trade Opportunities in Mexico

By M. de Moreira

The progress of Mexican commerce is the result of efforts made by various foreign countries, who, from the time of Montezuma until now, have recognized the great opportunities awaiting them there. The Spanish, the first in the field, became the shopkeepers and brought from Spain goods with which they were most familiar. England supplied the coal, railway and machinery, and Englishmen were the first to build a railroad in Mexico, and also to introduce new mining methods. Frenchmen coming over with Maximilian, at the time of the intervention, brought with them the silks and arts of France. Germans sent men to open branches of various commercial houses and have, therefore, a very good trade. The merchants of the United States have also, during recent years, comprehended what a great field they have in Mexico and have increased their trade every year more and more, making the Mexican the best Latin American trade they have.

Though not as progressive in various industries as the largest South American republics, Mexico, nevertheless is following them very closely.

Railway Construction

The new Mexican-Pan-American railway has already been opened and the line is in active operation from San Jeronimo on the Tehuantepec railway to Tapachula, in Chiapas. The extension of that line will be continued to Port San Benito on the Pacific coast. There is also planned a new railroad passing through parts of the states of Coahuila and Chihuahua, the length being about 375 miles. As the promoters have ample capital, our manufacturers will encounter every facility for selling their products.

The new transcontinental railway across the lower part of the North American continent, which connects the port of Tampico on the Atlantic, with the port of Manzanillo on the Pacific was to have been 1031 miles in length, but the government has decided to build a cutoff between Guadalajara and Aguascalientes, which will reduce the route across the continent to about 800 miles.

A short time ago the National lines of Mexico agreed to begin the construction of a railroad from Durango to Mazatlan. The basis of this agreement is that the state of Durango and the Madrerero company will guarantee 6 per cent. interest for ten years on the capital invested. The building of this road has been brought about by the Madrerero company to secure an outlet for timber, as not very far away is the best pine timber in all Mexico.

The construction of the roads and the supplying of machinery and rolling stock will be done by the National Mexican lines and as they bought a short time ago, a large tract of timber land in that vicinity, there is no doubt that the work will be pushed with all the speed possible. This will mean to American manufacturers an opportunity to supply, not only railroad, but milling supplies as well.

Our manufacturers should, however, keep in mind that we are not the only people in this world and, that the Mexicans have begun to manufacture and have become more or less our competitors. To demonstrate this more clearly it seems well to state here, that the National railway lines of Mexico placed, not long ago, orders for 20,000 tons of new steel rails with the steel company at Monterey, Mexico, which order made the American industry lose over half a million dollars.

A Gulf Coast Canal

The construction of a canal along the Gulf coast from Tampico to Tamiahua, a distance of 120 miles, gives manufacturers of dredges, etc., an opportunity to meet European competitors. The canal, according to contract, must be five feet deep and 40 feet wide and will cost $20,000,000.

Power and Pumping Machinery

Manufacturers of machinery necessary for handling water for irrigation purposes can also begin trade with Mexico, as the Mexican government has made contracts for the use of the waters of Rio San Lorenzo in the state of Sinaloa for the irrigation of 247,000 acres of land.

Another enterprise of great value for our manufacturers is the utilization of the waters of Lake Chapola, concerning which the *Mexican Herald* says: "Arrangements have been made by Manuel Cuesta Gallardo, of Guadalajara, and Fernando Pimentel, of Mexico City, for the organization of a company to take over and work the concession for the use of the water of Lake Chapala for irrigation purposes and for the development of power on the Santiago river. It is believed that more than 400,000 acres can be irrigated from Lake Chapala. The power developed on the Santiago river will be used principally for pumping purposes."

It is known that this company will expend several millions of dollars in power and pumping machinery and our manufacturers should see that the totality of this order does not go to Germany, where undoubtedly it will go, if efforts are not made by American manufacturers to secure it.

Mining

Mining also gives opportunities in Mexico. Many mines of zinc are being worked and are in all possible conditions of development, from the simple tunnel adit, where the ore is found at the tunnel level to ore found at moderate depths of 100 to 400 feet. Drills, hoists, etc., are of the most primitive make, and uptodate machinery is very much needed. Coal-mining machinery ought to find an easy sale since Mexico possesses 300,000 acres of coalfields giving an average of 3000 tons per acre.

Oil Wells

Oilfields in Mexico are being actively worked. There are at present five companies in operation, the most important being the Mexican Petroleum company, whose main field of operation is located near the port of Tampico. Other fields are situated near Laguna, also in the vicinity of Tampico. The company has bored a number of wells, the capacities of which are estimated at from 500 to 1000 barrels each per day, and it is reported that a gusher, with a capacity of 1800 barrels daily, was opened up lately. The company, in addition to keeping its refinery constantly supplied, furnishes also about 4000 barrels of oil daily to the Mexican Central for use on its railway and also supplies the crude-oil market of a large portion of the republic. The Mexican Central railroad employs oil-burning engines on its main line and is having metal delivery and storage tanks built at various points on the line. Some three or four other companies are operating oil wells, one entirely American and the other native. Thus illuminating, lubricating and fuel oils are being manufactured and are a great source of revenue to their owners who, certainly, in view of the profits they make, would be glad to perfect their machinery and invest in time- and labor-saving devices manufactured in this country.

Beef Packing Houses

Mexico is not only taking advantage of its natural wealth, but is also trying to start new industries. The establishment of a National packing house demonstrates this fact. The company, when organized, received certain valuable concessions from the Mexican government, among them the permission to purchase the slaughter-house of the city of Mexico.

The price paid was $1,500,000. The company finds itself in the complete possession of the beef-packing business of Mexico, with one plant for slaughtering, refrigerating and packing already in operation at Uhupuan and a plant just organized in Mexico. The two plants have a joint capacity of 1100 head per day and the company is planning to build another plant in Vera Cruz and another, still larger, in Monterey, giving thus, four plants having a packing capacity of 3000 head per day. The Mexican government has, moreover, granted to the company the privilege of receiving its tinplate and supplies of machinery free of duty for a period of 20 years. Surely this is a great opportunity for American manufacturers of refrigerating plants and other machinery needed for packing and canning establishments.

Cement Manufacture

A plant for manufacturing cement has been established near Mexico; at Vera Cruz the manufacturing of wire nails is giving good results; at Nogales, a clothing factory has doubled its operations twice since its foundation; at Orizaba various factories of cotton yarns and cloth are imitating very favorably French articles of the same kind. All over the country there is abundant proof that it is progressing and that American manufacturers of machinery of many kinds have great opportunities to increase their sales providing they watch attentively the opportunities offered by this republic.

On account of its vicinity to this country the banking facilities are easier and financial investigations can be obtained in any part of the United States allowing, therefore, the American manufacturer to do business with the Mexican buyer in all security.

The American Railway Master Mechanics Association

The forty-second annual convention of the American Railway Master Mechanics Association was held in Atlantic City, June 16-18, and was well attended. The exhibit of machine tools and shop appliances varied from the lightest tool holder to the extremely heavy radial drills of both the Cincinnati Bickford and the Newton companies. These were both heavier than any similar machines ever before exhibited and represent the latest effort to go the high-speed drill one better.

Nearly all the machine tools were in operation, making a good working exhibition and showing the advantages of the various devices to those who were interested.

Those who recall the light cuts of a few years ago were particularly interested in the work being done on all classes of tools, such as drills, lathes, milling machines, planers, shapers, etc. One of the novelties was the driving of rivets by the explosion of gas in a cylinder like a gas engine. There was also a two-cycle, air-cooled engine on a section car for railroad work, in which the lubricating oil is mixed with the gasolene, goes in the same tank and does away with lubricating devices of any kind.

Among the exhibitors were: Ajax Manufacturing Company, Cleveland, O.; American Blower Company, Detroit, Mich.; American Specialty Company, Chicago, Ill.; American Tool Works, Cincinnati, O.; American Vanadium Company, Pittsburg, Penn.; Armstrong-Blum Manufacturing Company, Chicago, Ill.; Armstrong Brothers, Chicago, Ill.; Besly & Company, Chicago, Ill.; Boker & Company, New York; Bowser & Company, Fort Wayne, Ind.; Brown & Sharpe Manufacturing Company, Providence, R. I.; Bullard Machine Tool Company, Bridgeport, Conn.; Carborundum Company, Niagara Falls, N. Y.; Celfor Tool Company, Chicago, Ill.; Chicago Pneumatic Tool Company, Chicago, Ill.; Chisholm & Moore Manufacturing Company, Cleveland, O.; Cincinnati Bickford Tool Company, Cincinnati, O.; Cincinnati Planer Company, Cincinnati, O.; Cleveland Twist Drill Company, Cleveland, O.; Coe Brass Company, Ansonia, Conn.; Crane Company, Chicago, Ill.; Crosby Steam Gage and Valve Company, Boston, Mass.; Davis Expansion Boring Tool Company, St. Louis, Mo.; Davis-Bournonville Company, New York; Dixon Crucible Company, Jersey City, N. J.; Duff Manufacturing Company, Pittsburg, Penn.; Walter H. Foster, New York, N. Y.; General Electric Company, Schenectady, N. Y.; Goldschmidt Thermit Company, New York; Gould & Eberhardt, Newark, N. J.; Green, Tweed & Company, New York; Hill, Clarke & Company, Boston, Mass.; Edw. Harrington, Sons & Co., Philadelphia, Penn.; Joyce, Cridland Company, Dayton, O.; Landis Machine Company, Waynesboro, Penn.; Landis Tool Company, Waynesboro, Penn.; Linde Air Products Company, Buffalo, N. Y.; Link-Belt Company, Philadelphia, Penn.; Lodge & Shipley Machine Tool Company, Cincinnati, O.; Manning, Maxwell & Moore, New York; National-Acme Company, Cleveland, O.; Newton Machine Tool Works, Philadelphia, Penn.; Niles-Bement-Pond Company, New York, N. Y.; Norton Company, Worcester, Mass.; Norton Grinding Company, Worcester, Mass.; Queen City Machine Company, Cincinnati, O.; Revolute Machine Company, New York; Royersford Foundry and Machine Company, Royersford, Penn.; Ryerson & Son, Chicago, Ill.; Scully Steel and Iron Company, Chicago, Ill.; William Sellers & Co., Philadelphia, Penn.; Standard Tool Company, Cleveland, O.; Stoever Foundry and Machine Company, Meyerstown, Penn.; Tindel-Morris Company, Eddystone, Penn.; H. B. Underwood & Co., Philadelphia, Penn.; Watson-Stillman Company, New York; Western Tool and Manufacturing Company, Springfield, O.; Westinghouse Electric and Manufacturing Company, Pittsburg, Penn.; Yale & Towne Manufacturing Company, New York, N. Y.

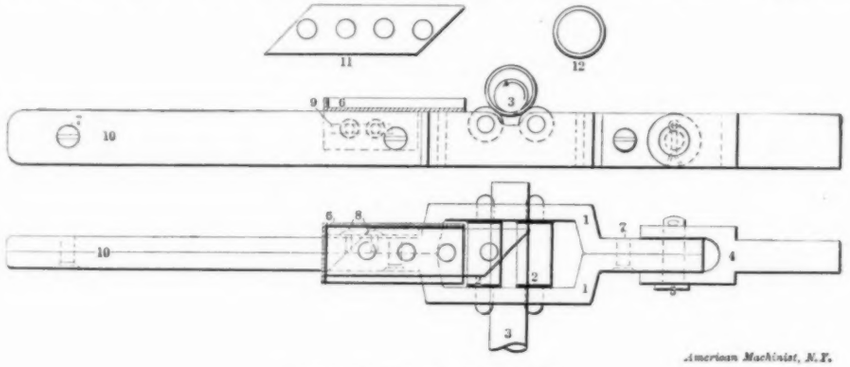
A Fixture for Rolling Rings

By W. Le Dierp

Some time back, when I was engaged with a firm making incandescent gas burners and lamps, I received instructions to make some arrangement for bending a few thousand air-regulating rings for ordinary bunsen burners. The problem was to make a cheap, effective device for rolling or bending the strips into cylindrical rings.

Strips corresponding to the development of one of these rings shown at *11* were cut from thin hard-rolled sheet brass. The air holes were punched under a press. The arrangement described and illustrated was made to bend these rings.

Two pieces of flat iron *11* were bent as shown to provide a space to take two



A FIXTURE FOR ROLLING RINGS

rollers *22*. When bent the two pieces were screwed together by three screws *7* with the rollers *22* in position to rotate freely. A fork *4* fitted with its single end in the tool post of a small lathe, was secured by the pivoting pin *5* to one end of the arrangement. A little tray or table *6* with two edges turned up to serve as guides was placed in position by two screws *8*, allowing of some adjustment by the slot *9*. A piece of round steel *3* was put in the chuck of the lathe centrally over the rollers *22*. The strips were then laid in position on the tray and the end *10* of the fixture was pulled up by hand, pivoting round the pin *5*, and pressing the strips between the rollers *223* and thereby bending them. Roller *3* was slightly roughened with a file to grip the strips and pull them along.

To get different diameters of rings (within certain limits) pieces of different diameters were used for the roller *3*.

This arrangement was cheap to make, simple to handle, and gave good results, taking only about one second for bending each ring; the lathe ran at about 300 revolutions per minute and 2 to 3 revolutions were sufficient to roll a ring.

Core for Converting a Three Part into a Two Part Mold

By George Buchanan

The use of cores as a means of making easy and simple many difficult and costly operations in the foundry is now being taken advantage of by many. The special advantages which any particular pattern

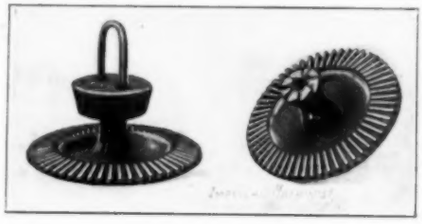


FIG. 1. BEVEL CLUTCH WHEEL AND PATTERN

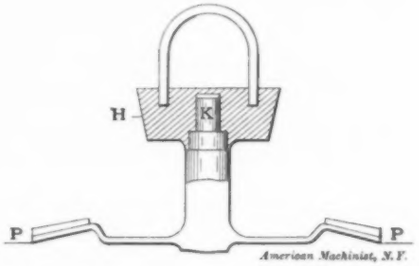


FIG. 2. PATTERN READY TO MOUNT ON MACHINE

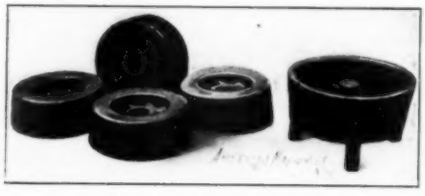


FIG. 3. CORES AND CORE BOX

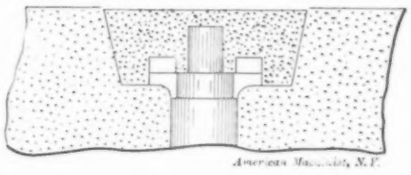


FIG. 4. THE CORE AS SET

equipped with coring-out methods gives must be judged not only by the increased and cheaper production of the piece so made, but also by the quality of the resultant castings.

In the case of the bevel-clutch wheel illustrated by Fig. 1, the quality of the casting is of importance, but accuracy is the principal thing desired, as the clutch must be perfectly true with the teeth of the wheel, a variation of 1/32 being sufficient to scrape the castings.

When made in a three-part flask some difficulty was experienced in producing castings of the desired standard of accuracy. Since, however, the coring-out method has been in operation no trouble has been found in securing a perfectly true clutch on the casting.

The accurate setting of cores, which form part of the exterior of a casting, is important, and much depends on sufficient guides in the shape of core prints. Badly fitting cores are the cause of many unsightly marks and laps on castings, so that, generally speaking, the coring-out method does not always find favor in repetition work. The present instance, however, has proved economical, and the accuracy and speed with which the cores are set leaves little to be desired.

By Fig. 2 is shown a part-sectional view of the drag pattern of the bevel wheel as mounted on the machine. *P* is the parting line and *H* is the tapered core print for the clutch. This is circular and is fitted to the turned spindle *K*, which is also the core print for the hub core.

The molding is as follows: The flask is placed on the stripping plate, facing sand riddled onto the teeth of the pattern, the flask filled up with floor sand, and rammed up to the top of the flask. The surplus sand is then struck off level with the top of the flask and the handle of the core print turned two or three times to slick the mold. The core print is next withdrawn and the clutch core placed in position.

In Fig. 3 will be seen some clutch cores and the core box. The clutch face of the core is made up with a special mixture containing six parts core sand to one of plumbago, the body of the core being filled in with ordinary core sand. The core is provided with a center hole which corresponds exactly to the spindle on which the core print revolves, so that it is this spindle which really sets the position of the core vertically. Fig. 4 shows how the core is set.

The core having been set, a little sand is sprinkled on the top of the flask and a plate rubbed on and clamped. The machine lever is now turned, drawing the pattern, and the mold lifted onto the floor, where it is fitted with a hub core and the top (made on a plate) closed on completing the mold. Fig. 5 is a sectional view of a mold complete.

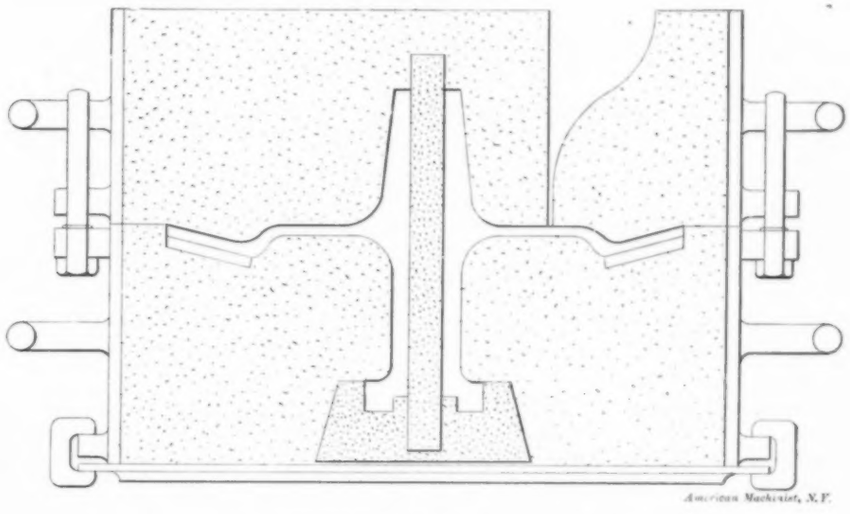


FIG. 5. SECTIONAL VIEW OF COMPLETED MOLD

According to an English contemporary, it is calculated that at the present time the United States are producing the following per week for 52 weeks in the year for every man, woman and child of the population of 90,000,000: Three-quarters pound of wire, more than ¾ pound of rails, ½ pound of structural shapes, ¾ pound of plates, ⅓ pound of sheets, ¼ square foot of tinplate, 2½ pounds of bars, hoops, etc., 4 pounds of iron castings. These and other finished iron and steel products make a total of 12 or 13 pounds each week per head.

Experiments conducted by Dr. Otto Schlick to overcome the rolling and plunging effect of ships in rough seas by means of a large gyroscope fitted to the hull of the vessel, are reported to have been so successful that an English shipbuilding firm has acquired his patent rights in Great Britain, France and the United States. The experiments were conducted on a vessel 116 feet long with a displacement of more than 56 tons, the gyroscope installed having a flywheel weighing about 1100 pounds and measuring about one yard in diameter. The vessel plied through a gale, but there was practically no rolling motion, although the ship rose and dipped with the rough seas.

AMERICAN MACHINIST

Issued Weekly by the

Hill Publishing Company

JOHN A. HILL, Pres. and Treas. ROBERT MCKEAN, Sec'y.

505 Pearl Street, New York.

Correspondence on mechanical subjects solicited and paid for. Name and address must always be given—not necessarily for publication.

Subscribers can have address changed at will. Give old and new addresses.

Subscription price $4 per year, postage prepaid, to any post office in United States, United States possessions and Mexico. $5.50 to Canada. $7 in all foreign countries except Europe and British possessions in Eastern Hemisphere.

Hill Publishing Co., Ltd., 6 Bouverie St., London, E. C., will serve all subscriptions for Europe and British possessions in Eastern Hemisphere. Price 30 Shillings for England. For all other countries in Eastern Hemisphere, 35 Shillings.

Entered at New York Post Office as mail matter of the second class.

Cable Address, "MACHINIST," N. Y.
Business Telegraph Code.

CIRCULATION STATEMENT

During 1908 *we printed and circulated* 1,205,750 *copies of the* AMERICAN MACHINIST.

Our circulation for June, 1909, *was (weekly, monthly and European)* 91,250.

July 1..... 34,000

This paper reaches 34,000 *separate readers each month and* 91,250 *each week.*

None sent free regularly, no returns from news companies, no back numbers. Figures are live, net circulation.

Contents

	PAGE
Some Remarkable Printing Office Devices	1
Automobile Cylinder and Piston Finishing	7
A Large Job on a Small Planer	9
Engineering in the Eighteenth Century	10
An Interesting European Vertical Miller	15
Comparison of Power Efficiency on Automatic Screw Machines	18
Grinding Small Holes with Diamond Taps	19
A Turning Tool for Wood	20
Gages and Fixtures for Testing Ball Bearings	21
Twist Drills and Their Tangs	26
Practical Letters from Our Readers: Safeguards on Rapid Acting Machinery....Grinding Automobile Motor Pistons....A Sawing Jig for the Milling Machine....Foremanship Courses	27-28
Discussion of the Previous Question: Locating a Gear to Mesh with Three Given Gears....Transferring Holes ....Premium System in a Jobbing Shop....Method of Japanning Disks ....A Belt Drive Change....Current Practice in Steam Engine Design....A Stud Extractor for the Turret Lathe	29-34
Trade Opportunities in Mexico	35
A Fixture for Roller Rings	36
Core for Converting a Three Part Into a Two Part Mold	37
An International Involute Gear Tooth Standard	38
New Tools and Machine Shop Appliances	40

An International Involute Gear-tooth Standard

In spite of prejudiced and distorted testimony to the contrary the fundamental English and American standards of measures are identical and thread unalterably through both the weft and the warp of Anglo-Saxon civilization. The uniformity of such standards should be recognized and reiterated. Proposed changes that would destroy this uniformity in any degree must be overthrown. Proposed changes tending to increase this uniformity as regards details should be fostered and encouraged. Whenever a new industrial standard is proposed both nations should coöperate in its creating and establishing, and thus still further erect and strengthen the structure of standards that is the heritage of the English-speaking race.

International coöperation of this kind in a broader way is, to be sure, desirable, but hardly seems possible because of the conflict between the rational English system of units and the theoretical metric system.

It is with the deepest satisfaction that we note such a desire on the part of English engineers to coöperate with us in establishing an international industrial standard as shown by a letter in *The Engineer* of London for May 28, an editorial in the same journal of June 11, and a communication from the Institution of Mechanical Engineers to the American Society of Mechanical Engineers. They refer to an international gear-tooth standard. The letter was written by P. V. Vernon, an English engineer, who unquestionably has the right to be considered an authority on the subject of gearing, and, who is a member both of the English Institution of Mechanical Engineers and the American Society of Mechanical Engineers. We quote this letter entire:

"A committee has been appointed by the Council of the Institution of Mechanical Engineers to investigate some questions connected with gearing; and quite independently a committee has been appointed by the president of the American Society of Mechanical Engineers to formulate a standard for involute gears.

"It occurred to me that it would be a very excellent thing if the Institution of Mechanical Engineers and the American Society of Mechanical Engineers would coöperate in this matter, which is one of particular difficulty and which would benefit greatly from the united wisdom of experts in the two countries.

"I also think that any standard which might be recommended by the committee in question would have a better chance of acceptance by engineers generally if it could be made to apply both in England and in America.

"I have been informed by the secretary that my suggestion will come before the Council of the Institution on June 11. It is also suggested that the hands of the Council will be strengthened if there were a general opinion in this country in favor of taking joint action with the American Society.

"A very great deal of experimenting is at present going on in this country in gear tooth form, but as the experiments are not made under any central authority, it is doubtful whether they will result in a standard which is likely to be universally adopted.

"The object of this letter, therefore, is to suggest that those gentlemen or firms who are interested in the subject of gear-tooth service should write to the secretary of the Institution of Mechanical Engineers, expressing their agreement with the suggestion and their hope that joint action will be taken.

"I have suggested that the way in which coöperation could be carried out would be to arrange with the American Society of Mechanical Engineers to exchange results with the Institution as arrived at, so that the final report as presented will be in substantial agreement.

"Trusting that this suggestion will do something to remove the great lack of uniformity which at present characterizes gear tooth practice."

The establishing of, and work done by, the English committee is thus referred to in the editorial that we have mentioned.

"Some of our readers will remember, but probably—since no report has been issued—the majority will forget, that in 1907 the Research Committee on Friction was re-established by the Institution of Mechanical Engineers for the purpose of investigating the action of spur, worm and chain gearing. In 1908 this committee contented itself by collating information about the work of other experimenters, and as far as we know, that is all that has actually been done to the present day."

In commenting on the situation in regard to Mr. Vernon's suggestion the editorial writer of *The Engineer* says:

"The proposition appears to us to be thoroughly sound and it is, we are in a position to know, supported by several of the most eminent firms of gear wheel makers in this country. Mr. Vernon's suggestion, we understand, is that the two societies should communicate the results to each other and endeavor between them to arrive at a standard agreeable to both. It, of course, remains to be seen that the American society is willing to coöperate in this way, but the invitation must come from this side, and it is, we understand, to be decided at the Council's meeting this Friday evening, June 11. In view of the increasing importance of the subject we trust that the Council may see its way to adopt Mr. Vernon's suggestion, as there can be little doubt that if the two institutions work together the very best result would be obtained."

The invitation thus foreshadowed, has already been received by the Council of the American Society of Mechanical Engineers and referred to the special committee of five on a standard for involute gears.

We hope and believe that the movement which is just started will result in a "getting together"—in fact, we cannot conceive of any other result—from which will come an *international standard for involute gearing*. The advantages of such a course are too obvious to need discussion. Let us hope that our special committee which is now styled "On Standards for Involute Gears" will in due course be changed to "On International Standards for Involute Gears," and that the co-operation of the English Institution will still further strengthen the hands of our committee's members to brush aside precedent and present practice, wherever necessary to reach the very best standard possible within the general limits that surround the problem.

New Publications

STEAM TURBINES. Compiled and written by Hubert E. Collins. Published by The Hill Publishing Company, New York and London, 1909. Cloth; 186 pages, 4¾x7 inches; illustrated. Price, $1.

This is the tenth of the series of *Power* handbooks. It is intended to be helpful to the engineer who wishes to inform himself quickly and easily about steam turbines. It is essentially practical and uptodate. It is a compact manual or book of instruction for the operation and adjustment of the principal types of steam turbine. There are eight chapters under the following headings: "Curtis Steam Turbine in Practice," "Setting the Valves of the Curtis Turbine," "Allis-Chalmers Steam Turbine," "Westinghouse-Parsons Turbine," "Proper Method of Testing a Steam Turbine," "Testing a Steam Turbine," "Auxiliaries for Steam Turbines," "Trouble with Steam Turbine Auxiliaries." Some of the subject matter has been published in *Power*; the rest was especially prepared, with the aid of the manufacturers.

ENGINE LATHE WORK. By Fred H. Colvin. 180 4½x6¾-inch pages; 127 illustrations and numerous tables; indexed. Hill Publishing Company, New York. Price $1 postpaid.

This book is uniform in size and style with "Machine Shop Calculations" and "Machine Shop Drawings" by the same author. He states in his preface: "Back of the proper running of all machine tools are what may be called foundation principles which should be understood in order to get the best results. Every good machinist comes to know these principles and to apply them unconsciously, but this book has been written for the apprentice and younger machinists who may not have had the same opportunities." The fourteen chapter heads under which the principles of lathe work are set forth in this book are as follows: The Engine Lathe; Centering Lathe Work; Driving the Work; Tools and Turning; Steady and Follower Rests; Face Plate Work; Chucks and Chucking; Boring Tools; Taper Turning; Thread Cutting; Test Indicators and Their Use; Three Types of Centering Arbors; Good Examples of Engine Lathe Work; Care of the Lathe. Each chapter sets forth in practical fashion the details of that particular branch of the work indicated by its heading, and the numerous halftones and line engravings illustrate clearly the points dealt with in the descriptive matter, so that the book cannot fail to be interesting and instructive to the shop man, the young machinist and the apprentice. The first chapter contains two full-page illustrations of an engine lathe and a lathe carriage mechanism, with each part shown in place and numbered, and a complete list of these parts is given for convenient reference. A description is given of the carriage, the cross-feed gearing, the regular rod feed and gear train, the operation of the lead screw and carriage, the method of taking down the apron for inspection and repairs. In the chapter on "Centering Lathe Work" many illustrations are included showing methods of centering round and square work and regular and irregular forgings; the application of various types of centering tools and chucks; methods of drilling and reaming centers, squaring up ends, etc. A useful table in this chapter gives the diameter of center drills and countersinks for different diameters of work and the speeds at which they should be run in the centering operation. Information is included on the general subject of lathe centers and their uses, centers for special work, pipe centers, etc. Under "Tools and Turning" all kinds of lathe tools are shown, with their correct names, standard clearance and rake angles, and their applications to the work. Methods of setting tools, applying roughing and finishing tools, using the steady rest, cutting speeds and feeds, are a few of the features of this chapter. That portion of the book applying to face-plate work, chucks and chucking and the use of boring tools contains many points of value in everyday work, and also shows certain processes for handling occasional jobs which arise in most all shops and frequently tax the ingenuity not only of the young mechanic but of the wiser heads as well. Among the most important chapters of this book are the three on "Taper Turning," "Thread Cutting" and "Test Indicators and Their Use." The author's familiarity with these subjects is recognized by all who have read his earlier works. He has in the present volume handled these topics with unusual clearness and in a way that will appeal both to the practical man and to the apprentice. The illustrations, the tables, the explanatory matter are all to the point. In connection with taper turning, various illustrations show the different ways of setting the lathe; the use of taper boring bars; cutting taper threads; using the compound rest. Tables are included giving corresponding tapers in degrees and inches per foot; the distance to set over the tailstock or the taper attachment, per inch of length, for a given taper per foot or for a given taper in degrees. Thread cutting is explained fully, with ways of figuring gear trains, simple and compound; the cutting of multiple threads; using the compound rest for angular feeding of the tool; grinding and setting tools, etc. The standard forms of threads with tables of their proportions are given; and there is much other information on various phases of the subject such as cutting worm threads; using special chasers; the production of accurate screws; figuring gears to allow for contraction of threads in hardening; and so on. The chapter on the test indicator points out by means of suitable illustrations some of the uses of an instrument with which every mechanic must familiarize himself if he wishes to progress along the road toward higher-grade work and better remuneration. The final chapter, "Care of the Lathe" can be read with profit by everybody operating or having charge of lathes.

McGraw-Hill Book Company

The Book Departments of the McGraw Publishing Company and the Hill Publishing Company have consolidated under the corporate name of the McGraw-Hill Book Company with offices after July 1, at 239 West Thirty-ninth street, New York. This consolidation brings together two of the most active publishers of technical books in the country. The new company takes over the book departments of both houses with a list of about 250 titles, both industrial and college text books, covering all lines of engineering. It will continue as well the retail, importing and jobbing business of the two houses.

The officers of the new company are: President, John A. Hill; Vice-President, James H. McGraw; Treasurer, Edward Caldwell; Secretary, Martin M. Foss.

Mr. Hill is head of the Hill Publishing Company, which controls the AMERICAN MACHINIST, *The Engineering and Mining Journal*, and *Power and the Engineer*.

Mr. McGraw is head of the McGraw Publishing Company, which issues the *Electrical World*, *Electric Railway Journal* and *The Engineering Record*.

Mr. Caldwell has been manager of the McGraw Book Department for several years and Mr. Foss manager of the Hill Book Department.

New Tools and Machine Shop Appliances

Showing New Ideas in Machine Shop Equipment That Make it Possible To Do Better Work at a Reduced Cost

THE LATEST INFORMATION

A Sellers Car-wheel Lathe

A heavy-duty car-wheel lathe recently developed by William Sellers & Co., Inc., Philadelphia, Penn., is illustrated in assembly by Fig. 1. The essential features that were held in view in designing this machine are: to simplify manipulation, to build a machine to take the heaviest cuts at the highest speeds that are permitted with new high-speed steels; to have a machine of such capacity that it can turn all kinds of steel car wheels, or car wheels with steel tires from 28 inches to 42 inches in diameter, whether they be of plate, arm, or composite construction, without requiring any holes or openings in the wheels for bolts or drivers; and lastly, to provide for axles with inside as well as outside journals, and for axles with driving gears or armatures between the wheels.

Turning to the illustrations, the bed is of massive construction carrying one fixed and one movable head. Each head is provided with a face plate. These face plates are driven in unison by a cross-shaft and each face plate carries three positive toggle-grip drivers.

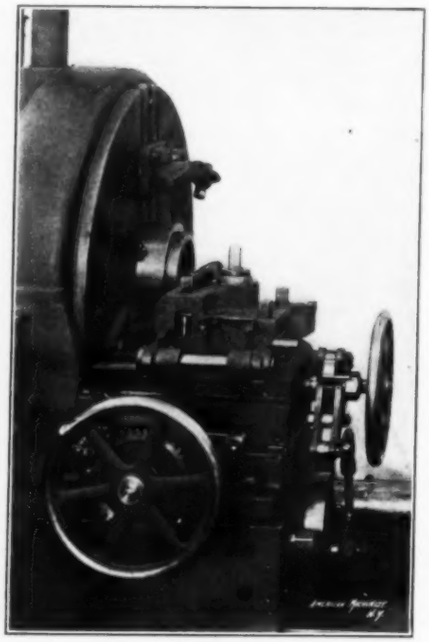


FIG. 2. VIEW OF TURRET OF CAR-WHEEL FROM THE FRONT

The main casting for each head is extended along the bed forming a support for the slide rest, so that the stresses due to the cut are entirely resisted by this main casting and do not tend to lift the head from the bed. The face plates are carried upon large sleeves with ample bearing surfaces. Within each sleeve is a sliding spindle having a tapered hole at the nose to accommodate clamping bushings for centering the wheel by the bearing surface of the axle journal. This method of centering, when possible, is preferred to the use of the axle centers as eccentricity may exist between the journal and the center due to wear. The spindle is provided with a spring to maintain a uniform pressure on the taper bushing. The movable head is moved and adjusted by means of an electric motor driving a screw through a slip clutch which prevents jamming. This motor and screw can be seen at the right-hand of Fig. 1.

The three drivers on each face plate are of steel. They are brought into contact

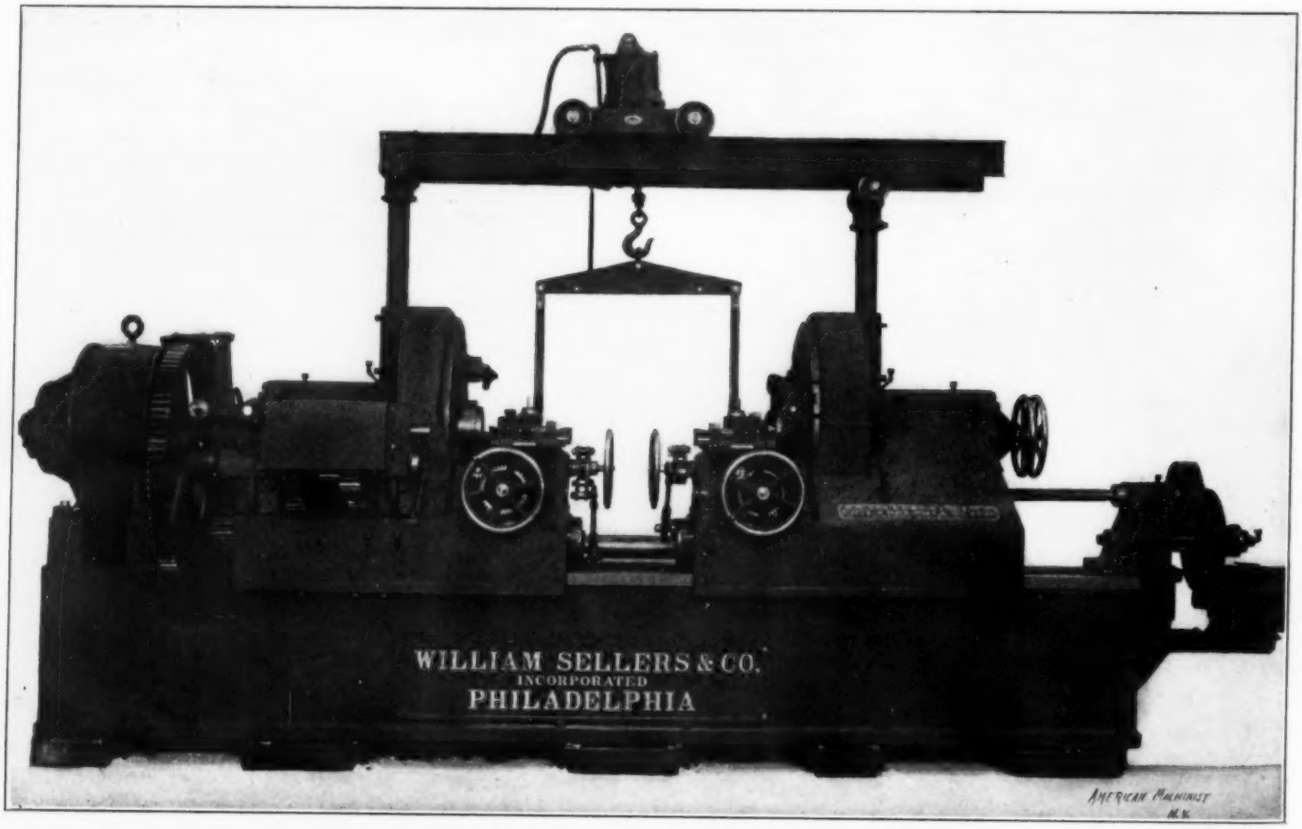


FIG. 1. SELLERS CAR-WHEEL LATHE

with the wheel and upon the application of the force of the cutting tool they grip the work to an increasing degree proportional to the power consumed by the cut. The tool post is an important feature of the design. Each one is an integral part of its respective head, thus the tool maintains a fixed relation to the face plate, irrespective of the gage of the wheels being turned. The turret contains four tools, which are all that are required for an entire wheel-turning operation. The locking device is one of the important features. It consists of two struts or cams fulcrumed on a pin supported in bearings at the rear of the turret slide and so arranged that the cams swing forward into contact with the turret or backward in order to release the turret and permit of indexing. This cam-locking device is extremely simple both in design and manipulation, as will be seen by reference to Fig. 2.

On each slide is a short section of track intended to match track on the shop floor so that wheels may be rolled into the lathe directly below the centers. Supported from the heads is a small crane provided with a hoist to be used in handling the wheels into and out of the machine.

The control is electric throughout from a panel conveniently located near the operator. The speed can be varied to correspond with the nature of the work; for instance, it can be slowed down for hard spots. A brake stops the motor as soon as the current is shut off.

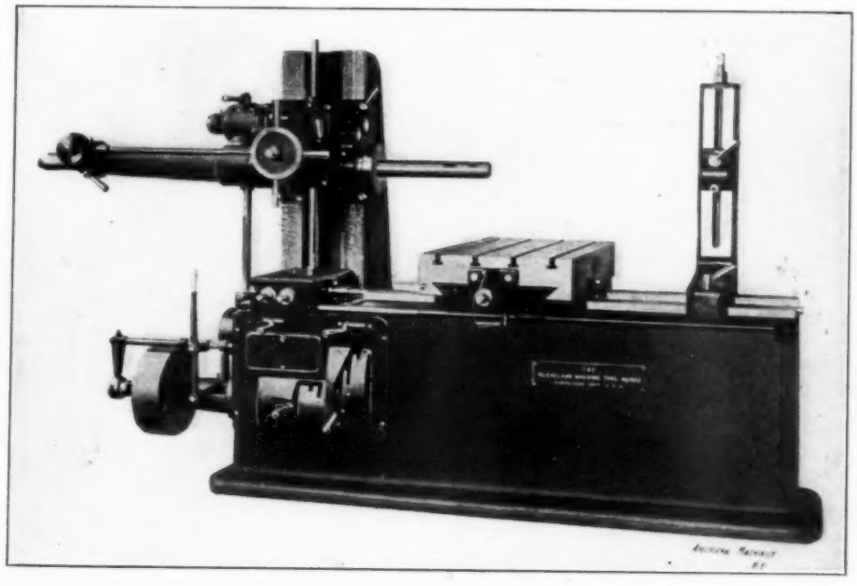
Horizontal Boring Machine

The type of boring machine seems to be growing in popularity if we can judge by the number that are being designed and built, the one shown being by the Cleveland Machine Tool Works, Cleveland, Ohio. The spindle movement, both revolutions, hand and power feed, quick traverse, as well as the back gear, are controlled from the head.

All the rest of the controlling handles are conveniently placed at the left of the machine. This includes the speed and feed changes, the feed reverse and a feed multiplier. There are 16 feeds for the head, platen and bar, 8 for each position of the spindle back gear and ranging from 0.005 to 0.3 inch per revolution of the spindle.

The machine has a 2½-inch spindle with 22 inches of travel and is fitted with a No. 5 Morse taper. The power feed is in either direction or it can be clamped solidly for face milling. The drive is by a 4-inch belt on a 14-inch pulley, giving 12 speeds in geometric progression; the gear ratio from driving shaft to spindle is 7 to 4, while the back gear is 12 to 1.

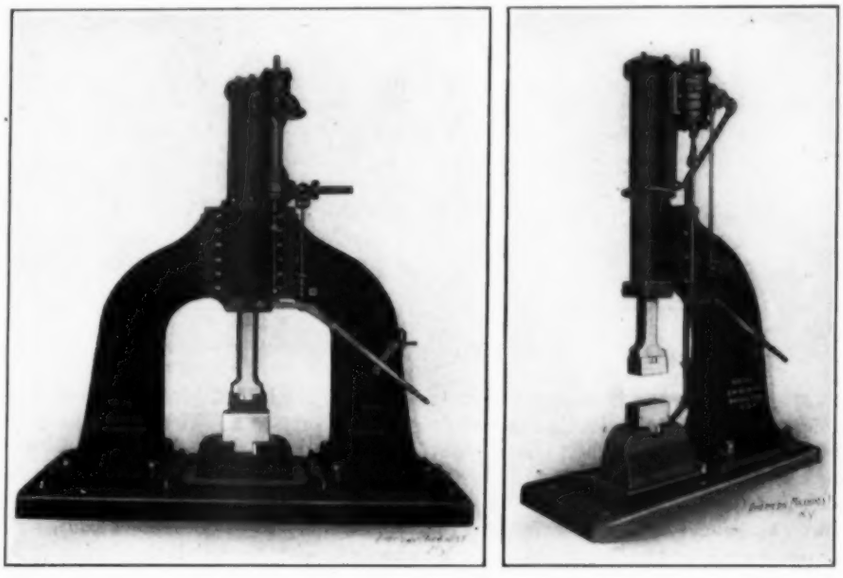
The platen in 20 by 36 inches with a 24-inch travel, micrometer adjustments being provided. The outer bearing is adjustable and removable and can be alined by a scale reading to 1/64 and 0.01 inch direct and to 0.001 with a vernier. The head can be moved 20 inches on the column, the vernier adjustment covering 18 inches of this.



A HORIZONTAL BORING MACHINE

A Compound Pneumatic Hammer

The E. W. Bliss Company, Brooklyn, N. Y., has brought out a line of pneumatic hammers similar in appearance to steam hammers but to be run with compressed air. As few modern shops or outside construction operations are without a compressed-air plant to operate the smaller pneumatic tools, and as these hammers are very economical in the use of air, their installation is not, as a rule, a matter of much expense.



TWO STYLES OF COMPOUND PNEUMATIC HAMMERS

The hammer is capable of two distinct types of blows; the one by the falling weight of the piston and other attached moving parts aided by the expansion of the air used to lift the piston to top position, the other by admitting air at full pressure on top of the piston resulting in a blow approximately 50 per cent. heavier than the other.

The extra-heavy blow can be given at will by the operator, it being necessary to depress the operating lever only slightly farther than its position for the lighter blow.

As there is no condensation a blow can be struck at once without any preliminary "working out;" for this reason the automatic striking attachment has been dispensed with. Figs. 1 and 2 show hammers with single and double housings.

The hammers are made in 10 sizes, from 150 to 6000 lb. falling weight. The maximum blows per minute for the smallest is

120, while for the largest it is 30. Air at 80 pounds (the usual shop pressure) has been found to be the most economical. The consumption of free air in cubic feet per blow when using air compressed to 80 pounds varies from 0.158 for the 150-pound hammer to 11.2 for the 6000-pound hammer.

Variable Speed Countershaft

There are many forms of speed-varying devices for various purposes and this one shown is the solution worked out by the Moore & White Company, Philadelphia, Penn., for use on countershafts and with motors of any kind as in Figs. 1 and 2. It is a modification of the double cone pulley drive, separating the cones to give room for an endless "idler" belt between the cone and the connecting belt on the outside. The inner belts are built up with wedge-shaped contact strips on the inside to accommodate the varying diameters as they are moved along from place to place.

The different speeds are secured by moving the driving belts to any position on the cone by means of the hand chain and screw.

Both shafts are in adjustable bearings so that alinement can easily be maintained and the tension of the belt regulated to some extent. The range can be varied by differently proportioned cones and can easily be made sufficient for all ordinary work.

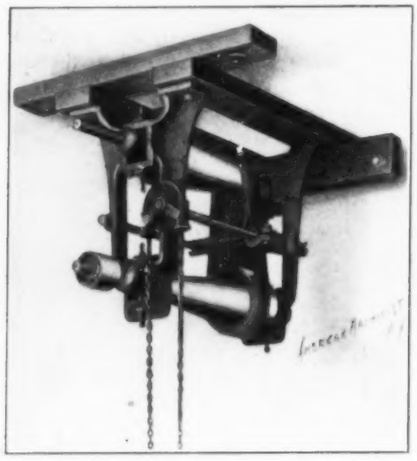


FIG. 1. VARIABLE SPEED COUNTERSHAFT

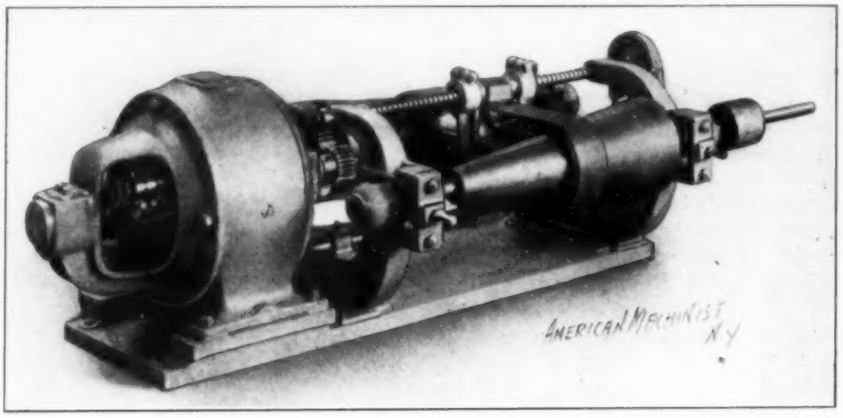


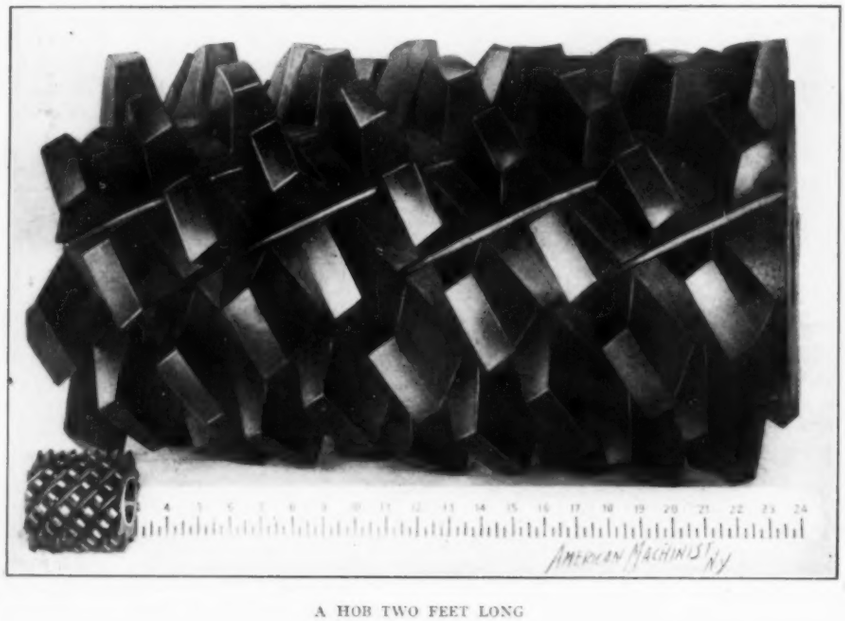
FIG. 2. VARIABLE-SPEED DEVICE COUPLED TO A MOTOR

A Very Large Hob

While it is probably courting criticism and proof of prevarication to call this the largest hob, it will undoubtedly make a close second to any that even the oldest machinist can remember.

It is 15.4 inches in diameter, 25⅜ inches long with a hole apparently 3½ inches in diameter. There are seven threads, right-handed, with an axial pitch of 4 inches and a lead of 28 inches, while the lead of the grooves is 54.69 inches. The angle of the thread with the axis is 50 degrees and 25 minutes and the angle of the grooves 35 degrees 34 minutes.

A good idea of its size can be had from the scale at the bottom and by the hob at the lower left-hand corner, which is about 3x3 inches. Those who are familiar with the difficulties of making hobs will appreciate the work of the Brown & Sharpe Manufacturing Company, Providence, R. I., in producing such a hob as this in perfect condition.



A HOB TWO FEET LONG

A Small Welding Outfit

To meet a demand for a small welding outfit for repair shops and garages, the Autogenous Welding Equipment Company, Springfield, Mass., has put out the outfit shown with this. No generator is included, as a tank full of gas will do a large number of jobs and can be replaced by charged tanks at a nominal cost. Oxygen is also supplied in the same way. This is known as the Davis-Bournonville

SMALL WELDING OUTPUT

Junior outfit, which has a torch and other fittings suitable for the work intended, but less expensive than the regular outfit. The applications of this method of welding are becoming too well known to need extended notice.

Some Improvements in Tilted Turret Screw Machine

The Wood Turret Machine Company, of Brazil, Ind., manufacturer of "The Tilted Turret" screw machine, has recently made some important improvements in its machines, and among these is the continuous automatic bar feed, for feeding the stock through the spindle. In Fig. 2 is shown the compact case in which this roller feed is contained, and a good idea of the internal construction may be obtained from Fig. 3. There are four gears and a scroll which impart motion to two rollers, while a second scroll is used to fit the adjusting jaws to the stock used.

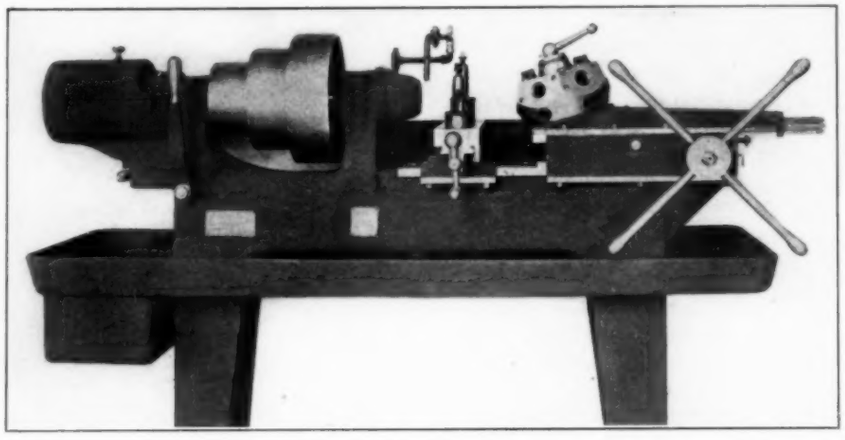


FIG. 1. THE NEW TILTED TURRET SCREW MACHINE

When the lever at the front of the head, Fig. 1, is pushed over to the left, a wedge is forced between the two pivoted brake arms, and the forcing of these apart causes the other end of the arm to close around a scroll E, Fig. 3, and grip it. The scroll being held still and the spindle carrying the roller feed case revolving, gives motion to the gears F and G meshing with the scroll E, and hence through the gears H and I, to the rollers J and K, which roll the stock in or out, according to the direction the spindle is revolving. In moving the lever over to the right, the chucking collar acts on the chucking fingers which, in turn, force the plunger in the spindle against the spring collet, which is thus closed to grip the stock. In this way one lever controls two operations, and eliminates the danger of trying to roll stock into the machine when it is gripped by a collet. As shown in Fig. 2, arrangement has been made for adjusting the four jaws which hold the stock. These jaws receive their adjustment from a scroll L, and in turn adjust the rollers that roll the stock through the spindle. Provision has been made in the stock-adjusting jaws to take round, square, hexagon, or other stock. The turret slide rests and moves in a saddle, furnished with taper gibs fitted the whole length on each side providing a means of adjusting the slide sideways. The backward movement of the slide, which is operated by a pilot wheel, rack and pinion, revolves the turret. The saddle is gibbed to the outer edges of the bed by flat gibs throughout its entire length. There is a supplementary taper base to the saddle by means of which the tool holes in the turret can be adjusted to the exact hight of the center of the spindle.

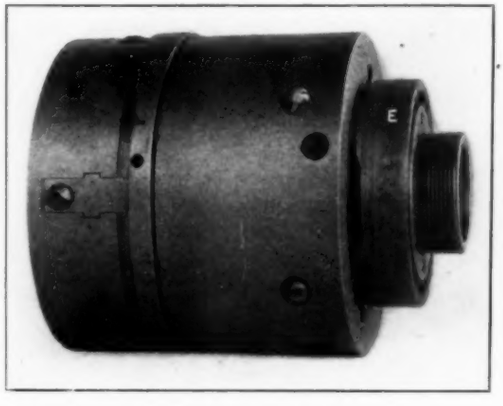


FIG. 2. THE ROLLER FEED

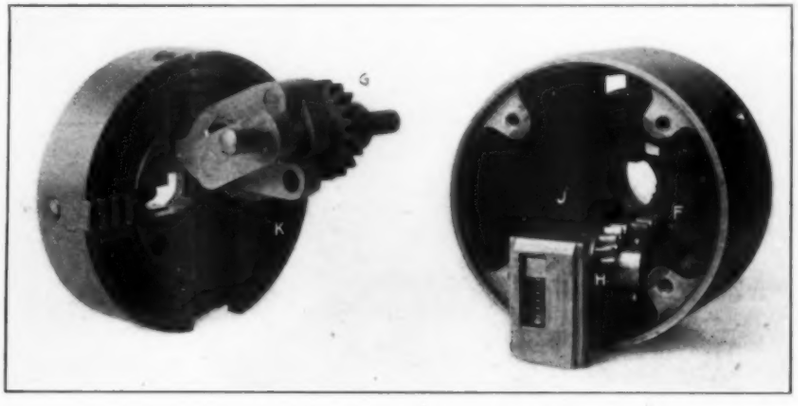


FIG. 3. DETAILS OF THE ROLLER FEED

Equalizing Milling Machine Driver

All milling-machine men know the trials and tribulations that follow when they try to mill a taper piece with the ordinary lathe or milling-machine dog without setting the dividing head to the proper angle. The angularity of the piece causes the tail of the dog to move in and out of the slot in the face plate or along the driver and this gives an irregularity in the motion which is very noticeable when it comes to milling a square or cutting notches or flutes in a circular piece. Fig 1 shows a driver that equalizes itself and cuts a perfect square as shown in

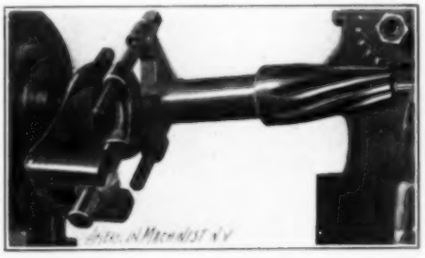


FIG. 1. EQUALIZING DOG FOR MILLING MACHINE

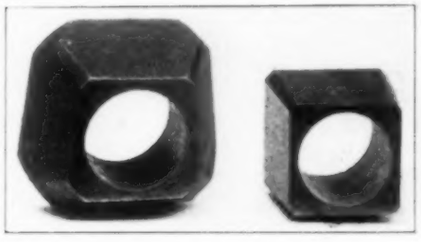


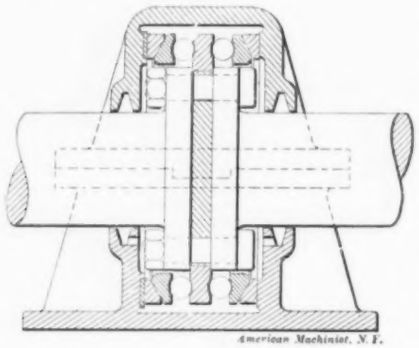
FIG. 2. EXAMPLES OF WORK

Fig. 2—the unequal piece being the work of an ordinary driver.

This equalizing driver needs little explanation as it shows very clearly how the ball which is carried on the tail of the dog, rolls in the groove in the tail or projection of the main driving portion of the device. This is clamped around the nose of the spindle and drives the dog through the sliding ball which plays in the groove and also on the tail of the dog. Lost motion is prevented by adjusting the screw in the driving end around the ball. It saves the time of adjusting the dividing head and gives a perfect job for all kinds of work. It is made by the M. B. Hill Manufacturing Company, 47 Hermon street, Worcester, Mass.

A Horizontal Thrust Bearing

The usual thrust bearing for propeller shafts is a cumbersome affair with a multitude of collars and taking up more



HEAVY HORIZONTAL THRUST BEARING

room than many designers like to allow for it. The thrust bearing shown has been designed to stand a thrust of 50,000 pounds in either direction and takes up little more space than two coupling flanges.

The central ball track is bolted between the couplings, being centered on a blind flange as shown. The outer races are spherically seated on adjusting plates which distribute the load evenly and take care of small changes in alinement. While this application is outside of machine-shop practice there are places on heavy tools where a smaller or modified form may be profitably employed. It is made by the Hess-Bright Manufacturing Company Philadelphia, Penn.

Multiple Spindle Automatic Screw Machine

At page 794, Vol. 31, Part 2, there appeared a description of the multiple-spindle automatic screw machine built by the Peerless Automatic Machine Company, of Cleveland, Ohio. The automatic screw machine here described is built by the same concern and is intended to handle a more general line of work and while, in parts, it follows closely the design of their first machine a number of new features are incorporated. Fig. 1 shows the front side, Fig. 2 the rear side and Fig. 3 the rear end of the machine. The stock spindles as well as the operating mechanism receive power from a single pulley running at a high, constant speed. This pulley is shown clearly at the left-hand end of Fig. 2. Power is transmitted through reducing gearing to a constant speed shaft shown in the center of Fig. 3 in horizontal alinement with the pulley-bearing shaft and from there through change gears to the spindle-driving shaft running through the center of the tool slide and spindle head. A set of change gears afford means of obtaining the speed most suitable for the work to be done and the material and tools to be used. The oil pump is driven by sprockets and chain from the pulley shaft.

When the tools are active, that is, operating upon the material, the cam mechanism is driven from the spindle driving shaft through the quick-change gear mechanism shown at the extreme right of Fig. 1. This mechanism gives five changes of feed for the tools and by interchanging the two gears shown in horizontal alinement at the left of Fig. 3, five more feeds are obtained. An extra set of two gears furnished, give ten more

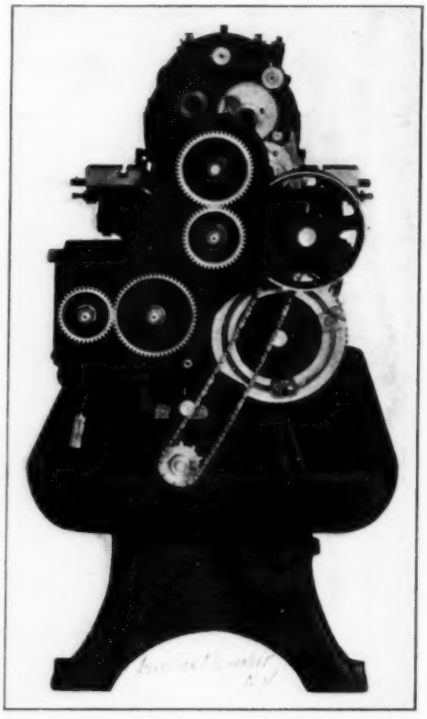


FIG. 3. END VIEW OF MULTIPLE-SPINDLE AUTOMATIC SCREW MACHINE

feeds in the same manner, thus making a total of 20 feeds ranging from 0.003 to 0.024 inch feed per spindle revolution. These feeds always bear a definite relation to the spindle speeds since the feed

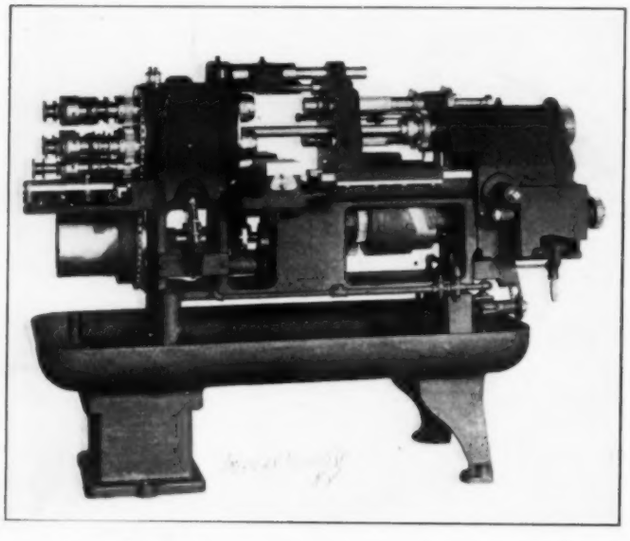


FIG. 1

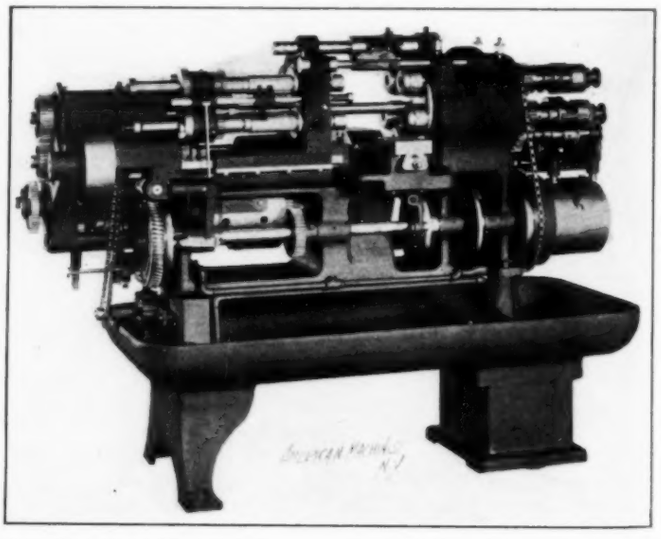


FIG. 2

MULTIPLE-SPINDLE AUTOMATIC SCREW MACHINE

mechanism is intergeared with the spindle-driving shaft. When the tools are inactive, that is, when no tools are operating upon the material, and while the spindle head is being indexed, the cam mechanism is driven direct from the constant-speed shaft. The machine thus always performs its idle movements at the same speed, irrespective of the spindle speeds.

The cam mechanism can be instantly disengaged and locked into disengagement by pushing the knob located below the feed box, shown in Fig. 2, forward, during either the active or idle movements of the machine, which can then be hand-operated by means of a crank handle which can be attached to the squared end of the shaft projecting from the feed box shown in Fig. 1. To set the cam mechanism into motion again, this knob is pulled outward, thus causing the proper feed to be started. It is impossible to start the fast feed when the tools are in their operating position, or to start the slow feed when the tools are in their idle position. The changes to and from the active and idle feeds or motions are accomplished by the adjustable cam dogs secured to the face of the worm wheel, shown in Fig. 3.

This machine is built with the knee type longitudinally moving tool slide carrying four tools and the stock stop. Two of these tools may be threading tools, either taps, dies or one of each. An auxiliary tool holder journaled on a stud held in the spindle-head cap and taking a bearing in the longitudinal tool slide, operates in either the third or fourth spindle position. It is oscillated onto the work by a cam adjustably carried by a rod fastened to and moving with the longitudinal tool slide. A spring returns the auxiliary tool holder to its normal position. The tool holder and operating cam are plainly shown in Figs. 1 and 2. The operation of the longitudinal tool slide, the threading spindles, the transversely moving tool slides, the spindle head locking and indexing mechanism, the stock feeding and chucking mechanism and the general construction of the stock spindles and the spindle-carrying head are nearly identical with those of the automatic screw machine previously described in these columns and need no further explanation. The gear guards are shown removed in the illustration to permit a more detailed view of the mechanism.

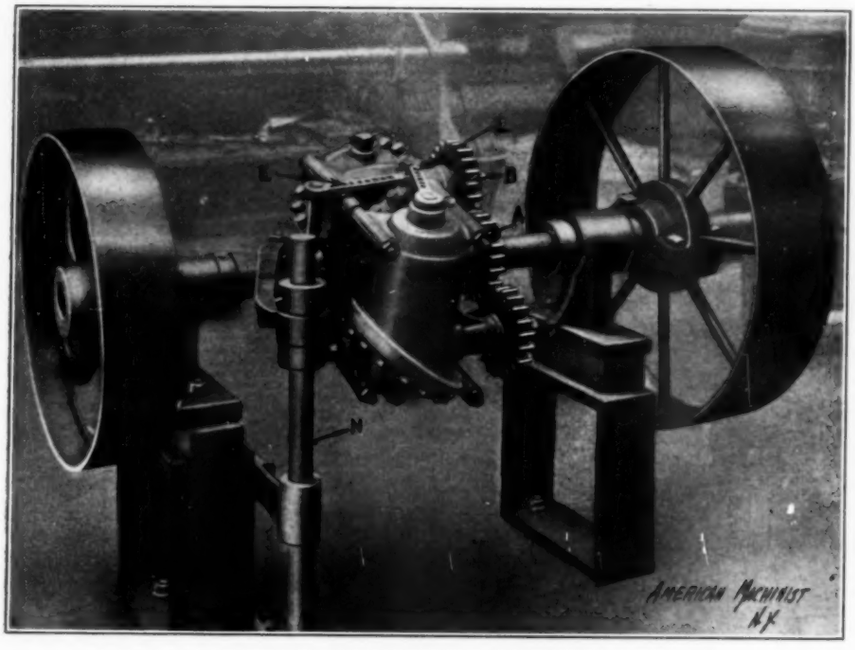


FIG. 1. A FLUID-OPERATED SPEED VARIATOR

A Fluid-operated Speed Variator

By A. Thompson

There is no doubt but that the demand for speed-variating devices is on the increase. Modern conditions demand a closer control and greater flexibility in speed than formerly; the question of speed control is alike a problem for the designer of the machine tool and the automobile. The classes of speed variators may be roughly divided into electrical, mechanical (under which heading are both positive and frictional devices) and fluid. The first two classes undoubtedly hold the field at the present time. The reliability and flexibility of the variable-speed motor and the reliability and relative cheapness of the gear box are each strong points in their favor. But the first is expensive and the second lacks flexibility. Frictional mechanisms have both these qualities, but in their usual forms they are not suitable for heavy duty. The third class, those employing a fluid, have not as yet entered into serious competition with the other types, though one or two examples have appeared in the technical press.

Fig. 1 shows a speed variator of the latter type. It is made by W. O. Harrap, of Manchester, England, and is patented. The mechanism is in simple terms a planetary gear motion, Fig. 2, where the spur wheel *A* is the driving and frame *C* the driven member. The order is sometimes reversed and the frame is made the driver. The variation in speed is obtained by checking the rotation of wheels *B* around their centers. If the wheels *B* were absolutely locked the frame would, of course, revolve at the same speed as the driver *A* and were they perfectly free to rotate the frame would not revolve against a load. The range of obtainable speeds lies between these two extremes.

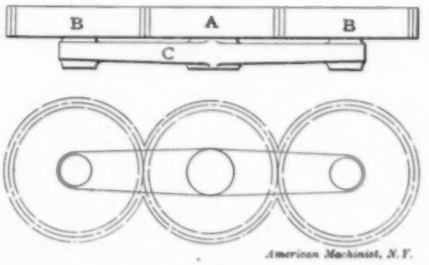


FIG. 2. DIAGRAM OF GEARS OF FLUID-OPERATED SPEED VARIATOR

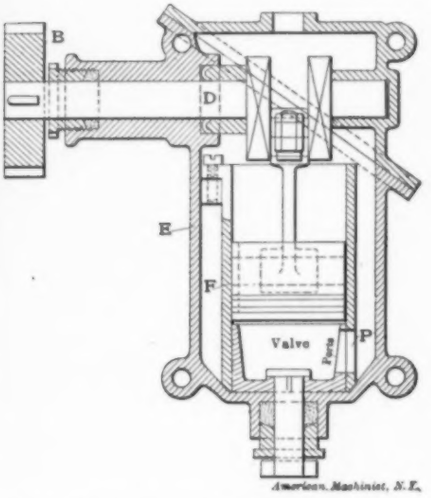


FIG. 3. CYLINDER AND PISTON OF FLUID-OPERATED SPEED VARIATOR

The feature of interest is the method of checking the rotation of the wheels *B* by small increments. Fig. 3 explains this. The wheels *B* of the diagram, Fig. 2, are here represented by the wheels on the end of the crank shafts *D* and the frame by the cylinders *E*. Within the cylinders is a liner *F* fitted with a piston connected to the crank shaft. The annular space between the liner and the cylinder wall is equal in area to the piston. The whole of the space within the cylinder is filled with oil and the rotation of the wheels

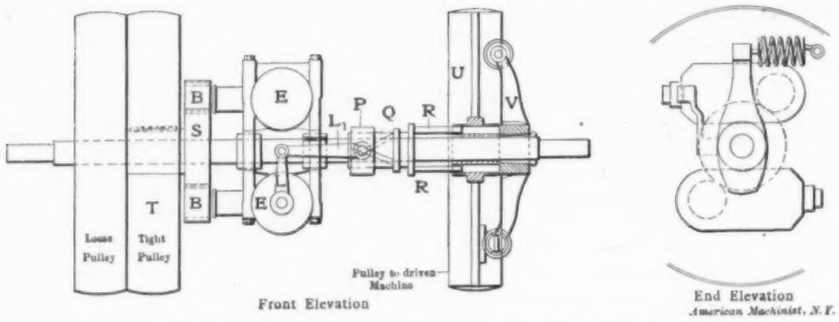


FIG. 4. FLUID OPERATED SPEED VARIATOR ARRANGED IN A COUNTERSHAFT

B forces this through the ports P which may be varied in area by rotation of the valve, which is connected by levers and links L, Fig. 1, to the rod for the speed-control handle N (Fig. 1). It should be added that there are two cylinders, one for each of the wheels B, and that their cranks are set at 90 degrees to minimize the variation in the combined piston velocities, as such variation tends to vary the rotative velocity of the wheels B.

It is obvious that the speed of rotation of the wheels B varies with that of their pistons and is dependent upon the velocity with which the oil passes through the ports. This, in turn, varies with the difference in pressures on either side of the port. Thus, other things constant, the speed can be varied by adjusting the port P by means of the control handle. While this arrangement has great flexibility for machine-tool driving, at least it has, in common with the series motor, the serious defect that the speed would be dependent to some extent upon the load; since the velocity of the oil through the ports is proportional in some degree to the pressure exerted by the piston upon it. Thus, if an extra load were thrown onto the gear it would, in turn, impress it upon the oil and the pistons and gears B would travel more quickly, with a resulting drop in the speed of the frame, for the same valve position. For purposes where a given speed must be maintained through fluctuations in load the design, Fig. 4, has been got out.

It will be seen that the driving pulley T drives the gears B by means of gear S, somewhat similar to the previous case; also that the cylinder frame is keyed to the shaft. But in this design the driven pulley is loose on the shaft and is driven by means of the arms U through the spiral springs. With an alteration in load, therefore, the relative angular positions of pulley U and the arms V, and consequently with the cylinder frame would vary. A sleeve Q having two helical grooves in its periphery is connected rotatively to the pulley by pins R. On this sleeve rides a bush P having tongues fitting the helical groove; it is also connected to the valve levers by the links L. Thus, any alteration in torque results in rotating the bush P on the sleeve producing endwise movement and regulating the valve to suit, the spiral springs being calibrated for a given torque. The sleeve Q is also connected to the speed-control handle in the usual way and alteration in speed is thus effected quite independently of this valve regulation for variation in torque.

Shaper Rig for Machining a Concave Table

By T. H. May

The accompanying sketches show a shaping rig designed to machine the concave table of a special machine we are

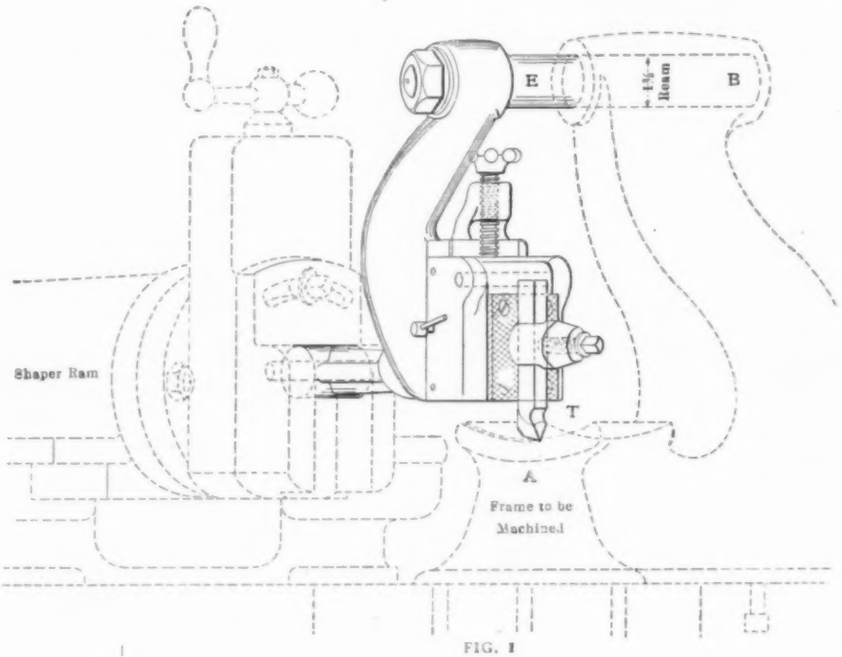


FIG. 1

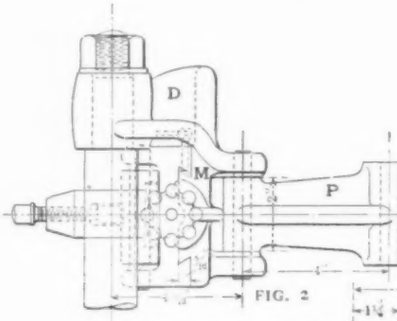


FIG. 2

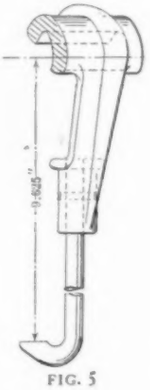


FIG. 5

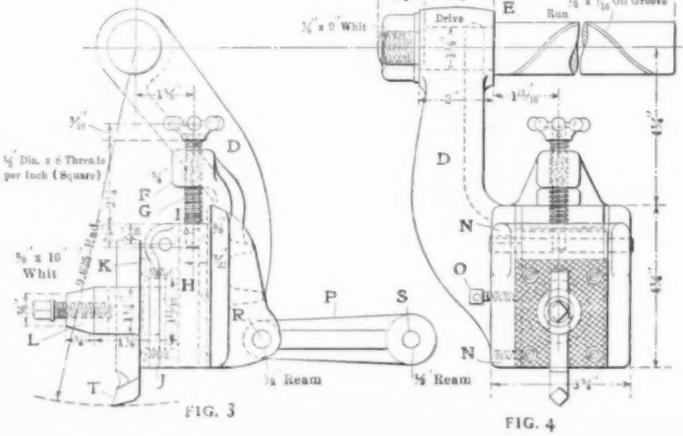


FIG. 3 FIG. 4

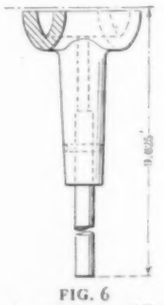


FIG. 6
American Machinist, N.Y.

SPECIAL SHAPING RIG

manufacturing in fairly large quantities, 300 being made at a time. This shaper device has proved a very good and reliable tool, giving accurate results, making a big saving over the old method of machining, which consisted in clamping the machine frame *A*, Fig. 1, onto the face plate of an engine lathe, with a plug in the bored hole *B* fitting the center hole of the lathe spindle, then balancing and turning the concave table *C*.

Figs. 2, 3 and 4 show clearly the construction and details of the tool, which consists of a cast-iron frame *D*, carrying a hardened and ground spindle *E*, which fits the bored hole *B*, in the work and about which it rocks when in motion. The spiral groove in *E* is for oiling. The boss *F* is part of frame *D* and is tapped for the feed screw *G*. The end of this screw is reduced to fit the hole in tool slide *H*, and has a semicircular groove turned for pin *I*, which is, of course, to prevent the screw from backing out of the hole in *H*. The clapper box *J* is of the ordinary type, with a hard-steel plate *K*, serrated on the front face for the tool to rest against, fastened to it, and bored out for the tool post *L*. Means for taking up wear on the slides is provided, by the gib *M*, and screws *N N*. The thumb screw *O* is for clamping the slide when taking a cut. The frame *D* is connected to the shaping machine head by cast-iron link *P* which is a nice fit on pin *R* driven in holes in frame *D*. At the other end the link *P* fits the regular shaper head in place of its clapper box, the pin of which fits in the hole *S*.

The operation of the rig requires very little explanation. With the work strapped down on the shaper table, and spindle *E* fitting hole *B*, the tool *T*, when the shaper ram is set in motion, will describe an arc concentric with hole *B*, and equal in radius to the radial distance from the center of *B*, to the point of tool *T*. As this radius is very important a setting gage, Fig. 5, was made for setting the tool *T* before taking the second and finishing cut and a test gage, Fig. 6, was also made, the use of which is obvious.

Albert Paulding Brayton

Albert Paulding Brayton, president and founder of the Pelton Water Wheel Company, of San Francisco and New York, died at his home in Oakland, Cal., on the June 25, aged 82 years. Mr. Brayton went to California in the early 50's and was conspicuous in the development of the industries of the Pacific coast, particularly in the development of the machinery industry as applied to mining and hydro-electric development. For many years he was a member of the firm of Rankin, Brayton & Co., who operated the Pacific Iron Works, one of the pioneer concerns in the metal industry in San Francisco. He retired from this concern in 1888 and established the business of the Pelton Water Wheel Company which, under his wise and vigorous administration, has since grown to be one of the most prominent concerns in the field of hydraulic-power development.

Forthcoming Meetings

International Association for Testing Materials, fifth congress, Copenhagen, Denmark, September 7-11.

The American Institute of Electrical Engineers, twenty-sixth annual convention, June 28 July 1, headquarters, Hotel Frontenac, Thousand Islands, N. Y. Ralph W. Pope, secretary, 29 West Thirty-ninth street, New York City.

Business Items

The American Pulley Company, Philadelphia, Penn., has opened a store at 139 S. Clinton street, Chicago, where a complete assortment of wrought steel belt pulleys and sash pulleys will be carried.

Business Opportunities

The Duplan Silk Company, Hazleton, Penn., will build an addition.

E. B. Norman & Co., Louisville, Ky., will establish a box factory.

The Geneva (N. Y.) Cutlery Company will build a new factory.

Eavenson & Levering, Camden, N. J., are increasing their power plant.

H. C. Stagner, Murphysboro, Ill., will build a garage and machine shop.

John F. Jelke & Co., Chicago, Ill., will erect a $400,000 butterine plant.

The Skinner Engine Company, Erie, Penn., is building a new machine shop.

The Soo Railroad has started the erection of a new roundhouse at Superior, Wis.

The Lovell Manufacturing Company, Erie, Penn., is building a new power house.

The Virginia Woolen Company, Winchester, Va., is building a three-story addition.

The Armstrong Cork Company, Camden, N. J., will build three additions to its plant.

The Yellow Pine Paper Mills Company, Orange, Texas, will treble the capacity of its mill.

The Shirley (Ind.) Radiator and Foundry Company will increase the capacity of its plant.

The Northwestern Reed & Rattan Company, Minneapolis, Minn., is to erect a new $50,000 plant.

The Bartholomew Company, Peoria, Ill., is contemplating doubling the output of its automobile plant.

The tannery of J. D. Dickinson & Sons, Woodstock, N. B., was destroyed by fire. Loss, about $50,000.

Horton Manufacturing Company, Augusta, Ga., will establish wagon factory, repair shop and garage.

The Heil Company, Milwaukee, Wis., manufacturing structural iron, will build an addition to its plant.

The Overland Automobile Company, Indianapolis, Ind., is to build an addition to its plant to cost $14,000.

The Cribben & Sexton Company, Chicago, Ill., has purchased site for a new stone plant to cost about $400,000.

A machine shop and blacksmith shop are to be erected at the plant of the Davenport (Iowa) Locomotive Works.

W. H. Leland & Co., Worcester, Mass., manufacturing grinding machines, etc., will build an addition to their plant.

The Carolina Paper Pulp Company, Newbern, N. C., will erect a new paper and pulp mill and remodel its old mill.

The Racquette River Paper Company, Potsdam, N. Y., has awarded contract for construction of a new paper mill.

The Harley Pottery Company, Nashville, Tenn., will erect a plant for the manufacture of fire brick, grate tiling, etc.

The Klots Throwing Company, of New York, owning several silk mills, will erect another one at Forest City, Penn.

A five-story addition will be built at the worsted and woolen plant of James Lee & Sons Company, Bridgeport, Penn.

The Allen Manufacturing Company, Nashville, Tenn., will build an addition for the manufacture of cast cooking stoves.

The Pond Manufacturing Company, Orange, Texas, will erect a new plant and install new machinery for general woodworking.

The Great Northern Railroad is to erect a new roundhouse at Butte and Great Falls, Mont. General offices are at St. Paul, Minn.

The Landay Steel Range Company, St. Louis, Mo., has purchased a building and will install machinery for manufacturing steel ranges.

The American Gear and Manufacturing Company, Indianapolis, Ind., will locate in Jackson, Mich., where a new plant will be erected.

Plans are being drawn for a new plant for the Sherman Machinery and Iron Company, Oklahoma City, Okla., which will cost about $250,000.

The power house of the Southern Colorado Power Company, at Trinidad, Colo., was destroyed by fire, causing a loss of over $300,000.

Wichita Falls Valley Railway Company will erect a roundhouse, repair shops, etc., at Stamford, Texas. D. B. Keeler, Fort Worth, vice-president.

The Boston and Maine Railroad is to start work soon on the new big repair shops in East Somerville, Mass. These are to cost over $1,000,000.

The Ranch & Lang Carriage Company, Cleveland, Ohio, manufacturing electric automobiles, will build a new machine shop and two other buildings.

The Stanley Manufacturing Company, New Britain, Conn., is to establish a branch plant in Niles, Ohio, for the manufacture of builders' supplies and tools.

The Hardian Buck Manufacturing Company, St. Louis, Mo., manufacturing railway supplies, is to build a new factory and warehouse to cost about $300,000.

Fred Hulbert, of Green Bay, Wis., has leased the plant of the Seymour (Wis.) Canning and Storage Company, and will install additional canning machinery.

The Isthmian Canal Commission, Washington, D. C., will receive bids up to 10:30 a.m., July 19, for steel castings, pipe machines, etc., as per circular No. 520.

It is reported that the Eisner Machine and Manufacturing Company, of St. Louis, Mo., contemplates establishing a machine shop in Ada, Okla.; also a bag factory.

The Arkansas Foundry Company, Little Rock, Ark., a new concern, will erect a plant and equip for general foundry business. Address is 811 East Fourth street.

Plans are being prepared for a new plant for the Keystone Supply and Manufacturing

Company, Philadelphia, Penn., making plumbers' supplies. This is to cost $60,000.

G. K. Seed Planter Company, 100 South Commercial street, St. Louis, Mo., will establish a plant for the manufacture of seed planters. Will need presses, saws and punches.

The Page Hersey Iron Tube and Lead Company, Toronto, Ont., has awarded contract for the construction of a new plant at Welland, including rolling mills, furnaces and a machine shop.

Fire destroyed the plant of the Peninsular Milled Screw Company, Detroit, Mich., causing a loss of $150,000, and the plant of the Michigan Stamping Company, Detroit, causing $50,000 loss.

The Keystone Steel and Wire Company, Peoria, Ill., is to make improvements at its plant to cost about $60,000. The fence factory will be enlarged, and changes made in the power plant.

William Whitman, Brookline, Mass., controlling two of the largest cotton mills, is interested in a new mill to be erected at New Bedford, Mass., and to be known as the Nashawana mill. This is to cost $2,500,000.

Bids will be received until 10 a.m., July 22 at the department of Justice, Office of Superintendent of Prisons, Washington, D. C., for furnishing and installing at the United States penintentary, Leavenworth, Kan., heating and ventilating apparatus for hospital building.

Sealed proposals will be received at the office of the General Purchasing Officer, Isthmian Canal Commission, Washington, D. C., until 2:30 p.m., July 6, for electrical fixtures, fittings, cable, wire, track drills, hardware, solder tape, etc., as per Circular No. 520-A.

The Isthmian Canal Commission, Washington, D. C., will receive bids up to 10:30 a.m., July 12 for malleable castings, steel, brass, bronze, copper tubing, boiler tubes, lock washers, steel cable, bolts, rivets, screws, cotters, air drills, hydraulic punch, post drills, ratchets, bits, milling cutters, taps, bellows, anvils, tool holders, pipe cutters, rail benders, saws, riddles, coal baskets, pulleys, carborundum wheels, valves, cocks, gages, gongs, pipe fittings, packing, etc., as per Circular No. 519.

The Navy Department, Bureau of Supplies and Accounts, Washington, D. C., will open the following bids: July 6—bolts, nuts, safety chains, hinges, brass screws, pipe taps, cutter, pliers, screwdrivers, shears, vises, wrenches (Schedule 1379), wire nails, hard rubber, rivets and bolts, coil springs, wheelbarrows (schedule 1378), aluminum (schedule 1380), brass bars, brass rods, flat steel, steel channels and angles, steel bars, forgings, machines, pipes, etc. (schedule 1376), brass pipe, unions, valves (schedule 1381); July 13—die-sinking machine (schedule 1384; July 27—motor-driven saws (schedule 1385).

New Incorporations

The Muskogee Iron Works, Muskogee, Okla., has been incorporated. Capital, $50,000. Incorporators, G. S. Wilson, E. F. Mathey, B. V. Ruppel.

Corrugated Expanded Metal Corporation New York, has incorporated to manufacture building material. Capital, $25,000. Incorporators, J. Leberman, H. C. Magnus, C. W. Stern.

W. C. Clark Safe Company, New York, has been incorporated to manufacture safes, etc. Capital, $25,000. Incorporators, A. Fashay, Brooklyn; H. Goldman, F. Gisch, New York.

American Laminated Belting Company, New York, has been incorporated to manufacture belting, lacing, etc. Capital, $50,000. Incorporators, F. P. Hopping, E. A. Usina, G. H. Smith.

Mechanical Tire Company, Jersey City, N. J., has been incorporated to manufacture rubber tires, etc. Capital, $500,000. Incorporators, H. C. Coughlan, S. A. Anderson, C. B. Leggett.

Eclipse Tanning Company, Newark, N. J., has been incorporated to manufacture leather goods. Capital, $975,000. Incorporators, J. S. Fearnon, A. Weil, New York; P. W. Jones, Cranford, N. J.

The Atlas Hanger Company, Chicago, Ill., has been incorporated with $50,000 capital by Wm. J. Moore, Geo. M. Stevens and R. E. Lee. The company will manufacture iron, steel, metal and wood products.

The Briggs-Shaffner Company, Winston, Salem, N. C., has been incorporated to conduct a machine shop. Capital, $125,000. Incorporators, W. C. Briggs, W. F. Shaffner, H. T. Richter, etc.

The Morrison Motor Car Company, Chicago, Ill., has been incorporated to manufacture automobiles and accessories. Capital, $20,000. Incorporators, Jas. T. Morrison, Harry E. Pierson, Otto H. Wolfe.

The Flexible Aeroplane Company, Newark, N. J., has been incorporated with $100,000 by Joseph Formanus, James K. Murgatroyd and Harold Taylorson, and will manufacture aeroplanes, automobiles, etc.

The Twin Heat Stove Company, Lebanon, Ind., has been incorporated to manufacture stores and do a general foundry business. Capital, $50,000. Incorporators, W. W. Swain, N. D. Byram, E. E. Gates.

The Hinman Milking Machine Company, Oneida, N. Y., has been incorporated to manufacture milking machines. Capital, $15,000. Incorporators, A. V. and R. L. Hinman, Munnsville, N. Y. Ralph Munson, Oneida.

The Benjamin Pulverizer Company, Phillipsburg, N. J., has been incorporated to manufacture pulverizing mills, etc. Capital, $50,000. Incorporators, M. Benjamin, Atlanta, Ga.; W. H. Walters, C. Walters, Phillipsburg.

Philip C. Traver Manufacturing Company, Far Rockaway, N. Y., has been incorporated to manufacture accessories for automobiles, bicycles and carriages. Capital, $50,000. Incorporators, P. C. Traver, L. Pearsall, G. Breng.

The Unique Manufacturing Company, Chicago, Ill., has been incorporated to manufacture printers' tools and other mechanical devices. Capital, $100,000. Incorporators, C. G. Kitte, T. J. Morgan, Julius Rubinstein.

The Senn Manufacturing Company, Camden, N. J., has been incorporated to manufacture steel-pressed hoes and other farm tools. Capital, $50,000. Incorporators, Edward Senn, Jr., George Senn, Otto Boysen.

The Ingle Brothers Check Credit System Company, Dayton, Ohio, has been incorporated to manufacture machines for credit systems. Capital, $75,000. Incorporators, D. E. Ingle, E. H. Ingle, George Gerdes, etc.

Saver Manufacturing Company, New York, has been incorporated to manufacture washing machines, etc. Capital, $1,000,000. Incorporators, G. Winaub, Rochester; J. N. Patch, Brooklyn; M. Rosenholz, Tompkinsville.

The Brandon Machinery and Lumber Company, Brandon, Miss., has been incorporated. Capital, $10,000. Incorporators, W. F. Owen, Victor Martin, Forest Smith, etc. Will erect building and install machinery for general machine repairing and woodshop work.

New Catalogs

Waltham Machine Works, Waltham, Mass. Folder illustrating and describing escape-wheel cutting machine.

The Ball & Wood Co., Elizabethport, N. J. Catalog of Rateau-Smoot turbines and generators. Illustrated, 6x9 inches, paper.

Edward Brown & Son, Philadelphia, Penn. Catalog of pyrometers, gages, etc. Illustrated, 32 pages, 7½x10½ inches, paper.

Wickes Bros., Cedar and West streets, New York. Bulletin No. 2, illustrating and describing new model gas and gasolene engine No. 2.

The United States Eectrical Tool Company, Cincinnati, Ohio. Catalog F, describing portable electric drills and grinders. Illustrated, 56 pages, 6x9 inches, paper.

Peerless V-Belt Company, 215 S. Clinton street, Chicago, Ill. Catalog describing Peerless V-belt. Illustrated, 12 pages, 3½x6 inches, paper.

The Wallace Barnes Company, Bristol, Conn. Catalog No. 5 of small springs, drop forgings, wire and steel. Illustrated, 36 pages, 5½x7 inches, paper.

The Curtis & Curtis Company, Bridgeport, Conn. Catalog describing pipe-cutting and threading machinery. Illustrated, 36 pages, 7½x10 inches, paper.

Manufacturing, Equipment and Engineering Company, 209 Washington street, Boston, Mass. Circulars illustrating and describing steel lockers, stools, racks.

Canadian General Electric Company, Toronto, Ont. Section No. 9, Supply Catalog, showing ignition appliances and auto accessories. 48 pages, 8x10 inches, paper.

Reed Manufacturing Company, Erie, Penn. Catalog G, describing vises, stocks and dies, pipe cutters, pipe taps, reamers, etc. Illustrated, 70 pages, 6x9 inches, paper.

Pittsburgh Valve and Fittings Company, Barberton, Ohio. Catalog C, showing complete line of iron pipe fittings, brass and iron valves, cocks, etc. Illustrated, 244 pages, 5x7 inches, cloth.

Saranac Machine Company, St. Joseph, Mich. Loose-leaf catalog of Advance automatic machinery for making butter dishes, baskets, stapling machines, etc. Illustrated, 7½x9½ inches, paper.

American Steam Gauge and Valve Manufacturing Company, 208 Camden street, Boston, Mass. Pamphlet describing American engine-room gage boards. Ilustrated, 10 pages, 6x9 inches.

Dean Brothers Steam Pump Works, Indianapolis, Ind. Catalog No. 77 containing lists of parts of pumps, directions for operating pumps and tables of information. Illustrated, 76 pages. 6x7 inches, paper.

Western Electric Company, 463 West street, New York. Pamphlet entitled, "First Rateau Regenerator Installed in America," by F. G. Gaesche, reprinted from *Power*. Illustrated, 20 pages, 8x10½ inches.

Murchey Machine and Tool Company, Detroit, Mich. Catalog describing pipe-threading and cutting-off machines, automatic collapsing taps, automatic opening dies, etc. Illustrated, 46 pages, 6x9 inches, paper.

Joseph Dixon Crucible Company, Jersey City, N. J. Booklet entitled, "Proper Care of Belts." Illustrated, 22 pages, 3½x6 inches. Booklet entitled, "Valuable Graphite Products," which is a pocket edition of the general catalog. Illustrated, 22 pages, 3½x6 inches.

Clayton Air Compressor Works, 114 Liberty street, New York. Bulletin C 204 illustrating and describing air compressors. 48 pages. 6x9 inches. Bulletin C 515 illustrating and describing vertical, single, belt-driven air compressors, 4 pages, 6x9 inches.

The Smallest Successful American Aeroplane

The Curtiss Machine of the Aeronautic Society Has Made Many Flights; Length 30 Feet, Weight 400 Pounds, Engine Capacity 25 Horsepower

EDITORIAL CORRESPONDENCE

On the afternoon of June 26 at an exhibition of the Aëronautic Society, held at the Morris Park Race Track, New York City, the society's Curtiss aëroplane—Mr. Curtiss as aviator—made two straight-away flights and a partial circle of the race track, including a very sharp 180-degree turn. This is the smallest successful, American aëroplane yet produced, and many who have seen it have said "that machine makes me want to fly." It is built by the Herring-Curtiss Company, of Hammondsport, N. Y.; is by far the best constructed airship that we have ever seen, and has made many successful flights, both at Hammondsport and at the Morris Park track. Its longest flight at the date of this writing has been about three miles, over a course in the shape of a figure 8. It has only 250 square feet of supporting surface in the main planes, and weighs complete only 400 pounds.

Its immediate predecessors were the four machines built by the Aërial Experiment Association, fully described in an article written by Mr. Curtiss and beginning on page 999, of our Volume 32, Part I.

Fig. 1 shows the machine in flight. The photograph from which the halftone was made was taken expressly for the AMERICAN MACHINIST on the afternoon of June 26 during one of the straight-away flights. Turning to the other illustrations, Fig. 2 shows the machine full front; Fig. 3, from the left-hand side, and Fig. 4, with the aviator in position. From these the machine is seen to be of the biplane type, with a front control for elevation, a stationary, horizontal, steadying tail-surface, and a vertical rear rudder for turning. At the ends of the main planes and placed midway between them are small, movable, horizontal balancing planes for establishing and maintaining equilibrium and as an aid in turning in the air. The machine is mounted on three wheels, enabling it to run on the ground in starting. The engine is situated midway between the main planes with a single propeller flanged directly to the crankshaft.

GENERAL DIMENSIONS OF THE AËROPLANE

The main planes have a total length of 28 feet, 9 inches, a width of 56 inches and are spaced 56 inches apart. The rear corners of each plane are clipped, as best seen in Fig. 3. At the center a notch is made in the rear of each plane of a sufficient length and width to permit the swinging of the propeller entirely within the lines of the planes. Each plane is made up of five sections. The center section, or section carrying the power plant, is 6 feet 3 inches long. The other four sections are each 5 feet long, with an overhang at the extreme ends of 15 inches, making a total length of 28 feet 9 inches. The framework of these main planes is of spruce with laminated ribs. These ribs are steamed and bent to shape from four-ply material, the two outer sections of which are of ash and the two inner of spruce. The spring of the curve is 4 inches measured from the chord at a distance of 24 inches from the front. This curve is said to be parabolic in shape, with a curvature of one in nine, and an angle of the planes with the horizontal of six degrees when the machine stands on level ground. In flight this angle is diminished.

The fabric covering the planes is a rubberized silk, fastened to the ribs by a band of featherbone securely tacked in position, and laced to the framework at the ends of the section by heavy lacing passed through eyelets. In front the fabric is wrapped around the frame and securely fastened; at the rear a wire runs through it and over the end of each rib to stretch it tight. This fabric is very light.

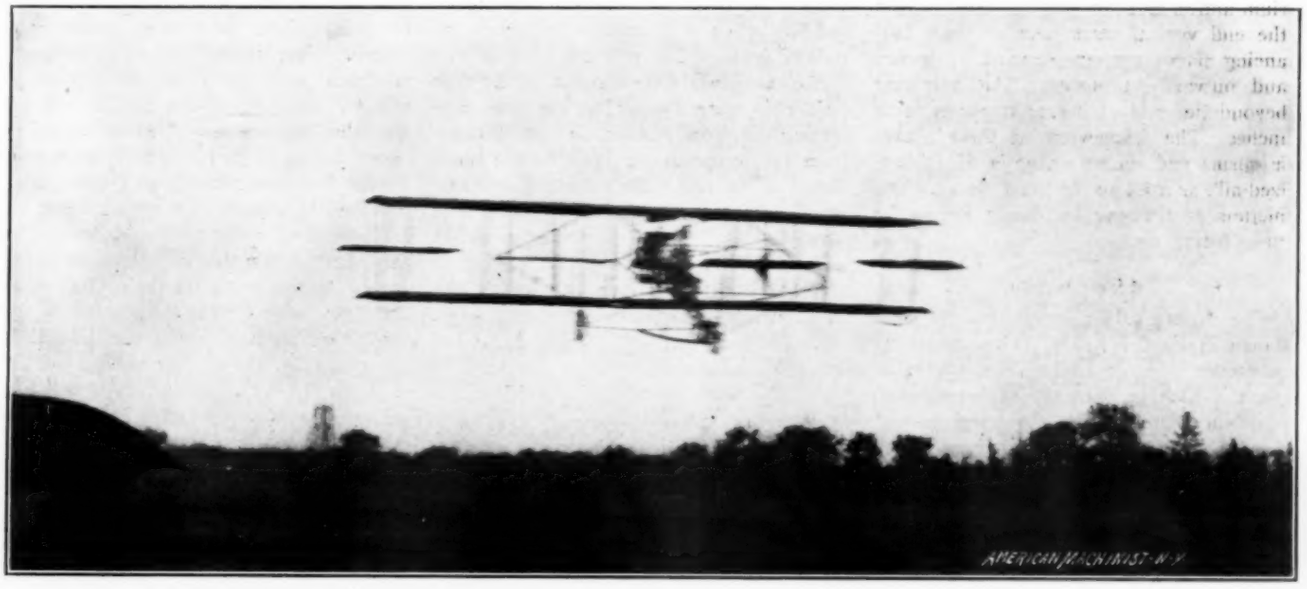


FIG. 1. HERRING-CURTISS AËROPLANE IN FLIGHT AT MORRIS PARK JUNE 26, 1909

The vertical struts between the planes are of Oregon spruce, of a general shape well shown in Fig. 3. The section of these, midway between the planes, is fish-shaped, 2¼ inches by 1 inch, with the wider end forward. The wire trussing is a fine wire cable heavily galvanized. The metal connections of the struts with the framework of the planes are a socket or joint, such as is used for connecting the various pieces of tubing in bicycle and motorcycle construction; in fact, the sockets actually used in this aëroplane were adapted from standard parts of Mr. Curtiss' motorcycle. When the machine stands on a level floor the hight from the floor to the top of the upper plane is 6 feet 10 inches.

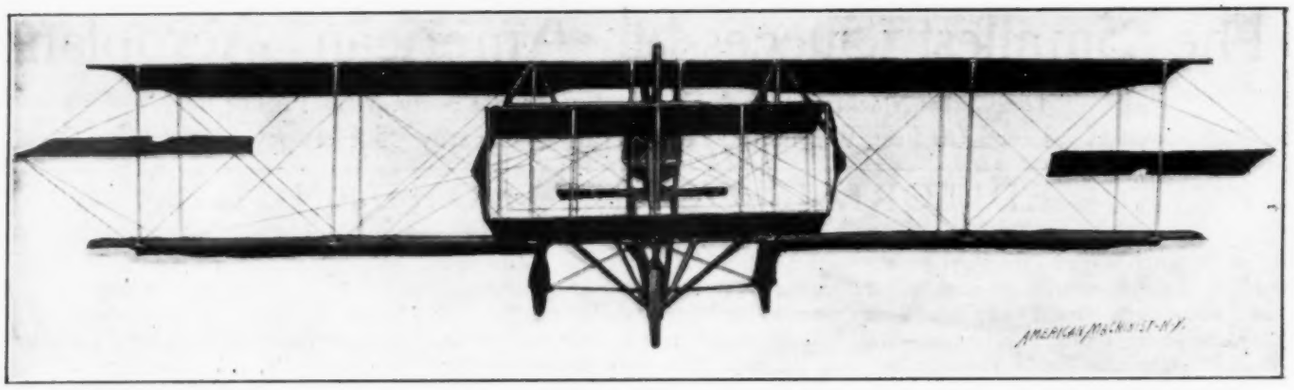


FIG. 2. FRONT VIEW OF AËROPLANE BUILT FOR THE AËRONAUTIC SOCIETY

Balancing Planes

The movable balancing planes are best shown in Fig. 2. They are 6 feet long, 2 feet wide, spaced midway between the main planes, are hinged about their front edge by a clip through the vertical strut and are operated in unison. When one plane is moved downward, the other one is moved upward an equal distance. Their use is to preserve the balance or equilibrium and to assist in making turns. From the end vertical strut each of these balancing planes projects inward 33 inches and outward 39 inches. The overhang beyond the ends of the main planes is 24 inches. The framework of these planes is spruce and the covering is of rubberized silk, as used on the main planes. The method of trussing is plainly shown by the illustrations.

Front Control

The front rudder or control is well shown in Figs. 2 and 3. The supporting cantilever is made of bamboo, averaging about 1 inch in diameter—apparently an excellent material for the purpose—and the trussing is of small galvanized wire cable. The distance from the front of the main planes to the horizontal axis about which the control swings is 12 feet. The hight of this axial point above the floor when the machine is standing level is 45 inches. Each plane is 6 feet long, 2 feet wide, and they are spaced 2 feet apart. Midway of their length is a vertical triangular plane 3 feet high on the front and having attached at this upper point a long bar or lever running back to the steering wheel and controlling the motion of the entire rudder. This vertical triangular plane has no motion with reference to the control planes, but moves with them. Its purpose is to add a certain amount of stability when the machine is struck by sudden gusts while in flight.

The cantilever truss supporting the rear rudder is very similar to the one supporting the front rudder, and its distance from the hinge to the back of the main planes is 12 feet. This control is composed of two planes: a horizontal immovable plane 6 feet long and 27½ inches wide to produce stability, and a vertical movable vane or rudder 2x3 feet in dimensions, hinged about its front edge, with a slit through which passes the immovable horizontal plane. This vane is under the control of the handwheel. Its motion, of course, is swinging sideways, and its purpose is to steer in making turns.

The Power Plant

The power plant is the most interesting development, and it is with pleasure that we present Fig. 6, showing it in detail. The engine is a four-cylinder, four-cycle Curtiss gasolene engine, especially designed for this machine. The valves are in the hemispherical head, operated by a single cam shaft, and both heads and bodies of the cylinders are water-cooled. It is splash-lubricated. The ignition is by means of a gear-driven Bosh high-tension magneto; and it is provided with a Curtiss carbureter. The cylinder diameter is 3¾ inches, and the stroke is 4 inches. Its rating is 25 horsepower at from 1200 to 1300 revolutions per minute. Its compression is high, although not abnormally so. The inlet and exhaust valves of each cylinder are located in the head as shown, and each set is operated by means of a rocker lever and a connecting rod running down to the cam shaft. From this cam shaft are driven the circulating pump for the cooling water, the force pump for the lubricating oil, and the magneto. This presents a design that is very easily accessible for inspection and repairs.

The gasolene-supply tank is located just under the top plane and is very long compared with its diameter. It has a capacity of three gallons. The radiator is of a common automobile type; it holds seven quarts of water and is located directly in front of the engine. The water-circulat-

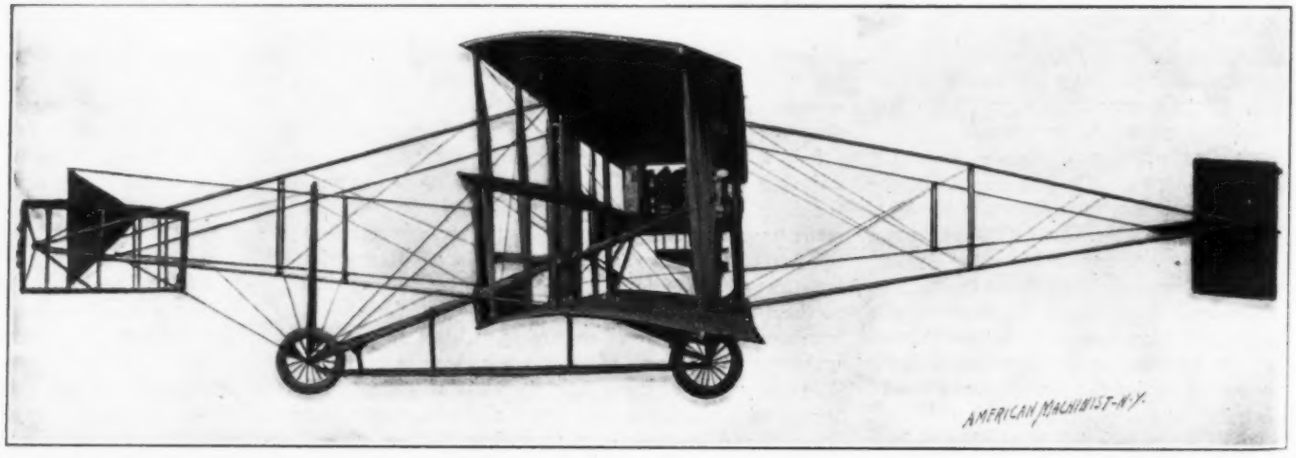


FIG. 3. SIDE VIEW OF AËROPLANE

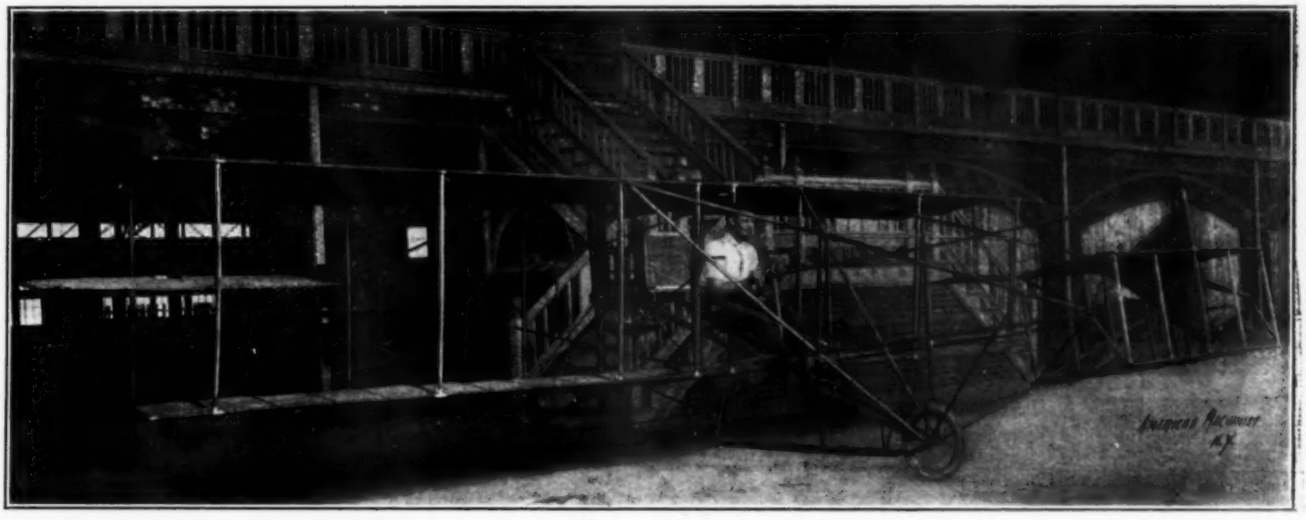


FIG. 4. PARTIAL SIDE VIEW WITH AVIATOR IN POSITION

ing pump is shown at the extreme rear of the engine, connected with the bottom of the radiator by a horizontal pipe. It is a geared pump. The lubricating-oil tank is swung below the engine and has a capacity of about 1 gallon. The force pump, which pumps oil from this tank into the crank case, unfortunately, cannot be seen in the illustration, Fig. 6. It is situated directly in the side of the crank case, and as we have stated, is driven directly from the cam shaft. The overflow from the crank case to the lubricating-oil tank is through two pipes, one located at either end. The propeller is flanged directly to the end of the crankshaft, as shown, thus making the simplest possible form of drive. Taking all these features into consideration, the motor is compact and is surely most simple in design and construction.

It is of interest to note the materials used in building this motor. The cylinders are of cast iron, with walls about 5/32 of an inch thick. Around each cylinder is a copper jacket, brazed to the cylinder and inclosing both the body and head. Thus both the cylinder and valves are water-cooled. The crank case is of aluminum, and the crankshaft of an alloy steel. The levers controlling the valves, their connecting rods, the piston, piston rods and connecting rods, are made from the alloy known as Macadamite. The piston snap rings are of cast iron. The connecting piping is of brass or copper. The propeller, which is 6 feet long, with an average width of blade of 6½ inches and a pitch of about 5 feet, is made from wood. It is attached at the hub by six bolts to the crankshaft flange. All of this power plant is mounted on a wooden frame made from ash and securely braced into the middle section of the machine.

The entire machine is mounted upon three 20-inch diameter by 7-inch hub pneumatic-tired wheels built especially for this service. However, none of these wheels is under control; therefore, when the machine runs on the ground the only method of guiding it is by means of the controlling planes. Near each end of the lower main plane is a runner to protect the plane should the machine tip in landing.

The weight of the engine, magneto, pumps and carbureter is 93 pounds, or about 3.7 pounds per horsepower. The radiator weighs 40 pounds, and when supplied with oil and water the weight of the power plant is about 150 pounds, giving a weight for the bare machine of 250 pounds.

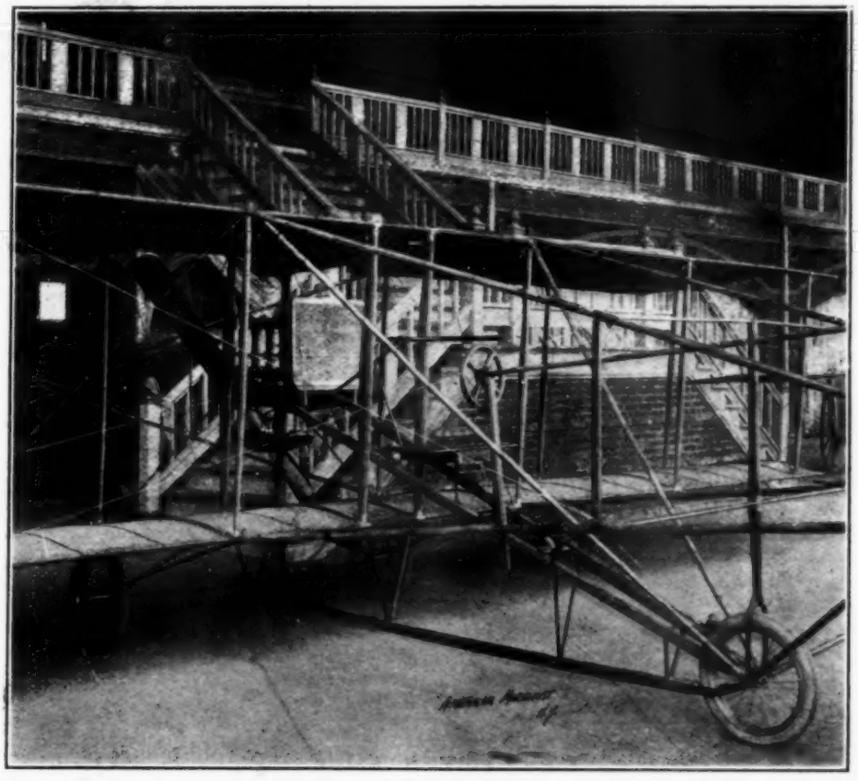


FIG. 5. DETAILS OF CONTROLLING MECHANISM OF THE AËROPLANE

Method of Control

The method of guiding and controlling this machine is worthy of some study, as it tends to show the strain to which an aviator is put while in flight. Several of the illustrations show the steering wheel. This wheel is on the end of a long bamboo rod, running forward to the front rudder, and by means of which the front rudder can be tipped to any angle desired. This is the control for hight. At the same time the hand-wheel can be rotated, and by so doing the vertical rudder at the rear is turned to any angle desired. The connection is by means of a wire cord passing around the wheel, through suitable pulley blocks and to the

rudder plane. The movable balancing planes between the main planes are connected by suitable wire cables to a yoke made of light bicycle tubing and best seen in Fig. 5. This yoke fits around the shoulders of the aviator, and by leaning to one side or the other he is enabled to set the balancing planes at any angle desired. It is maintained that such action is more or less involuntary, as a person riding or sitting in any structure will naturally lean to the high side in case the structure begins to tip. Directly beneath the aviator's wooden seat is a snap switch in the magneto circuit, by means of which the engine can be stopped if desired. At the same time both feet of the aviator are in use. The right foot presses against a small lever, connected by means of a wire cord to the engine's throttle. In this way the speed of the engine is controlled. The other foot rests against a lever, which if pressed produces two results. The first is to short circuit the magneto, thus stopping the engine, and the second is to put a plunger brake upon the front wheel. These two actions are brought into effect when it is necessary to stop the machine. To the inexperienced it surely seems as if the aviator's mind, hands and feet were in a high state of tension when the machine was in flight.

The propeller develops a thrust of 225 pounds when the machine is held stationary; however, only 150 pounds thrust is needed to fly. In a run of 75 feet the machine will attain a sufficient speed to rise in the air. This speed is about 25 miles per hour.

To show the ease of developing such a machine after the fundamentals are understood, this machine was designed and built in about one month at Hammondsport. The machine can be disassembled and made ready for shipment in two hours by two men, and can be reassembled in one day.

To show the relative size of the successful aëroplanes of American development, the accompanying table has been prepared. The Farman machine has been included as it has been exhibited in this country. The latest Curtiss machine has the smallest area of supporting surfaces and the least weight. Referring to Wright's machine it must be remembered that it was built to carry two men, while the Curtiss machine carries only one.

An interesting feature of the table is Column 4 which shows the flying weight per square foot of supporting surface for the machines. These factors for the Wright, Farman, "Silver Dart" and Curtiss machines are very close together.

1.	2.	3. Weight in Pounds.		4. Ratio.	5.	6. Power Plant.	
Name.	Supporting Surface, Sq. Ft.	Machine.	Men.	Col. 3 Divided by Col. 2.	Speed, Miles per Hour.	Engine Speed R.P.M.	Engine Power in H.P.
Wright	500	800	350	2.3	40	1400	25
Farman	560	1165	175	2.4	28	1050	38
"Red Wing"	385	500	175	1.7	....	1050	25
"White Wing"	408	600	175	1.9	37	1050	25
"June Bug"	370	500	175	1.8	39	1200	25
"Silver Dart"	420	710	175	2.1	....	1200	50
Curtiss	250	400	175	2.3	....	1200	25

SURFACE, WEIGHT AND POWER PROPORTIONS OF SEVEN AEROPLANES.

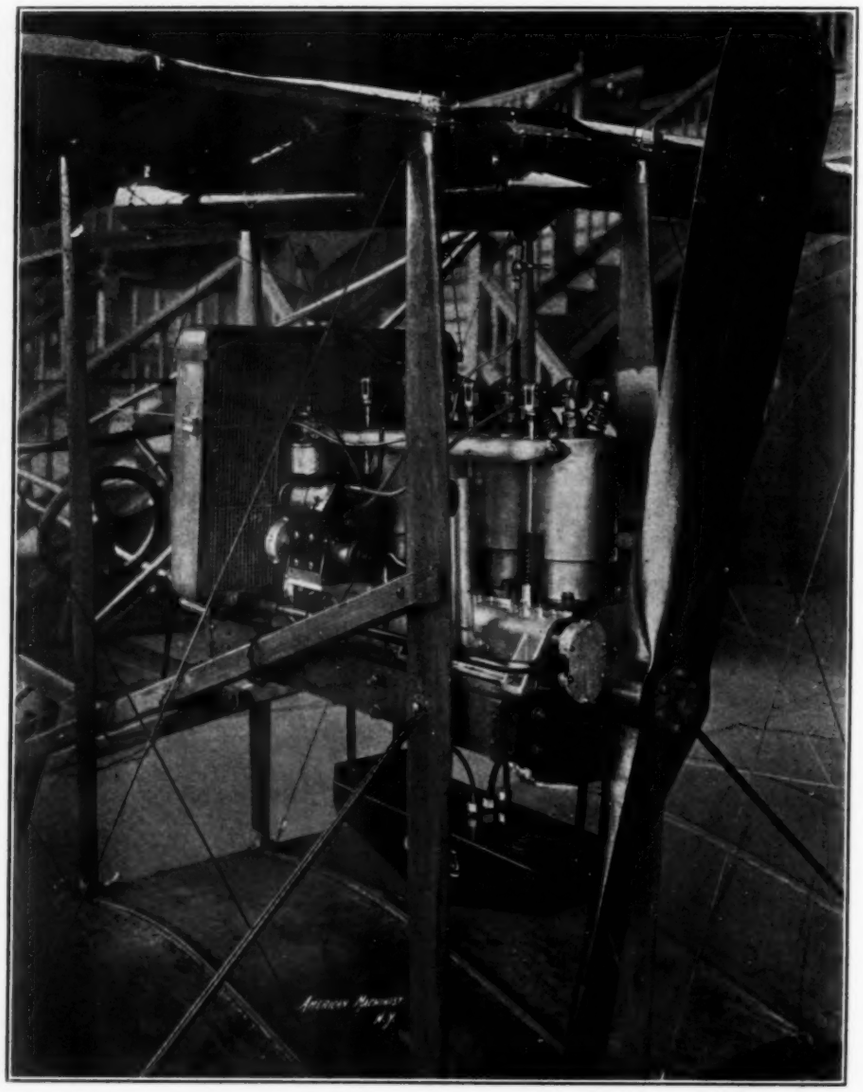


FIG. 6. POWER PLANT OF THE AËROPLANE

Automobile Engine Cylinder and Piston Finishing Practice

By Hugh Dolnar

The American Simplex Motor Car Company, Mishawaka, Indiana, has adopted the 2-cycle motor, and is building 7-passenger touring cars of most elaborate construction. Quality of workmanshinp and car reliability are the factory considerations.

The cylinder and piston finishing practice includes a final "running in;" the cylinders, pistons, rods and crank shaft are assembled, placed in a frame with the open ends of the cylinders up, and the crank shaft is then belt-driven at about 90 revolutions per minute with cylinder lubrication of oil, powdered soapstone and powdered glass. The cylinders and pistons were previously finished by grinding.

The cylinders are cast in dual units, the cylinder bore and the piston stroke being both 5 inches. The whole length of the

cylinder is finished inside and the bore traversed by the piston is ground accurately to diameter on a vertical grinding machine. The cylinder and piston finishing routines are given here to show what is actually being done.

The cylinders have integral water-jackets, are of gray iron and are cast in dual units. They are counterbored at the open end and have the combustion chamber, somewhat larger in diameter than the cylinder bore, finished inside by grinding only. The inside of the cylinder head is finished with a flat tool, with a whole

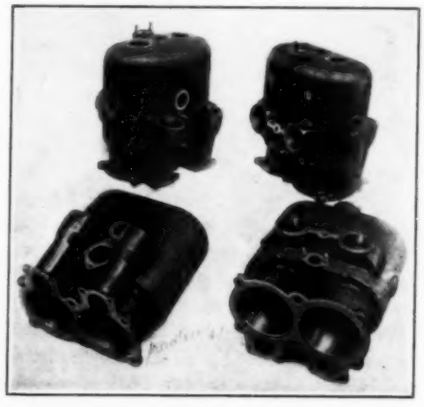


FIG. 1. AMERICAN SIMPLEX 2-CYCLE MOTOR CYLINDERS

FIG. 2. AMERICAN SIMPLEX 2-CYCLE MOTOR PISTONS

surface scraping cut at slow speed. The flanged lower ends of the cylinders are finally finished by lapping with oil and emery on a finished gray-iron surface which is not grooved. Neither the cylinder nor the piston castings are pickled. The castings are very smooth and true to size both outside and inside.

The Illustrations

Fig. 1 shows the finished dual-unit cylinder in four positions; Fig. 2 shows a finished piston in four positions; Fig. 3 is a piston plan and section with finished piston diameters and Fig. 4 shows the cylinder fixture on a Lucas boring-mill table and one boring head and the cylinder-flange, inserted-tooth facing mill on the machine spindle. Fig. 5 is from the rear of the cylinder-boring fixture and shows the fixture 2-position latch and fixture-edge latch groove. Fig. 6 shows the piston-spotting fixture, which positions the rough piston concentrically with the piston-cored interior surface and the rough-piston receiving bell chuck, all on the flat turret lathe; Fig. 7 shows the same assembly with a piston chucked on the spotting arbor, ready to be transferred to the bell chuck. Fig. 8 shows the cylinders, base, pistons, rods and crank-shaft assembly on the "running in" stand.

Cylinder Finishing

The cylinder-finishing routine is as follows: First operation, place cylinder in fixture on the table of the boring mill; time, 5 minutes. As the cylinders are cast in dual units and hence must have two positions in relation to the single boring spindle, the fixture base is tongued to slide in the table groove, and has two latch grooves cut in the rear edge to take the position latch, hinged to a bracket bolted to the table, as shown in Fig. 5.

The second operation is to face the flange, two cuts with the face mill; time, 10 minutes.

Third operation, rough bore both bores with a four-blade inserted-tool boring head, the fixture being shifted and latched; time 12 minutes.

Fourth operation, finish bore both bores with finished boring head, also having four inserted teeth; time, 12 minutes.

Fifth operation, finish the inside of the cylinder head by scraping with a full surface flat cutter; time included with operation four.

Sixth operation, counterbore using one flat double-end tool in the groove in out end of finishing head; time, 30 minutes. There are a number of other cuts on this cylinder which do not belong to bore- and flange-finishing and are, therefore, not detailed.

Seventh operation, rough grind the two cylinder bores and, at the same setting, grinding the combustion chamber cylindrical surface to a finished inside diameter; time 150 minutes.

Eighth operation, cut the circumferential oil groove in the cylinder with a single-point, narrow grooving tool fixed in the vertical spindle sleeve of the grinding machine; time 10 minutes. After these dry rough-grinding operations the cylinders unit is removed from the grinding machine and set aside to cool.

Ninth operation, return the cylinders unit to the grinding machine and finish grind both cylinder bores; time 150 minutes.

The tenth operation is lapping the flange with oil and flour of emery on a flat gray-iron plate by hand; time 150 minutes.

Piston Finishing

The piston-finishing operations are as follows:

First operation, in a Jones and Lamson flat turret lathe with a jaw chuck, chuck the piston with, say, ¾ inch of head end in chuck jaws and rough-turn the body up to the chuck jaws with a single-point tool in the tool-post; time, 10 minutes.

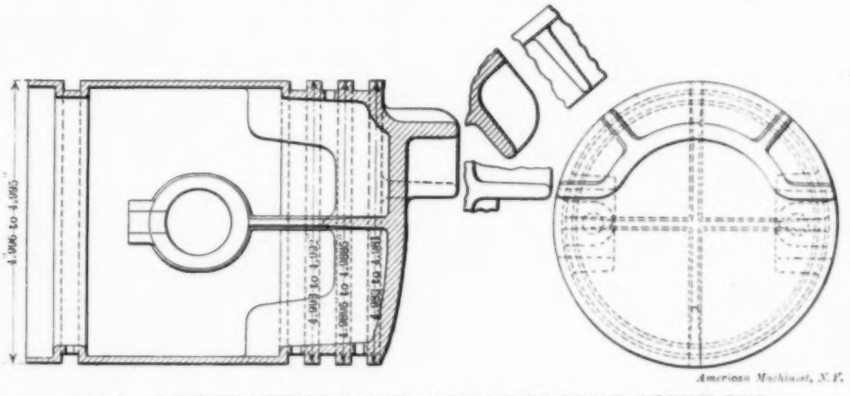


FIG. 3. AMERICAN SIMPLEX 2-CYCLE MOTOR PISTON 5-INCH CYLINDER BORE AND 5-INCH PISTON STROKE

Second and third operations, in the flat turret chuck the piston on two circumferences of four cone-expanded plungers in a special, screw-operated expanding arbor held in the turret, as shown in Fig. 6. This expanding arbor chucks the piston true with the inside cored surfaces. The face plate of the lathe carries a bell chuck, with two sets of 3 holding screws bolted to it, and the third operation is to finish the two inside surfaces at the open end of the piston with a single-end tool. The piston, chucked on the expanding arbor is first shoved into the bell chuck and the six bell-chuck screws are then carefully tightened on the piston outer surface so as not to crowd the expanding arbor over, then the expanding-arbor plungers are collapsed and the arbor is withdrawn to expose the piston interior for the outside end facing and boring cuts. The time for chucking the piston on the expanding arbor, then in the bell chuck, withdrawing the arbor and boring the two internal cuts is 10 minutes.

The fourth piston operation is to remove

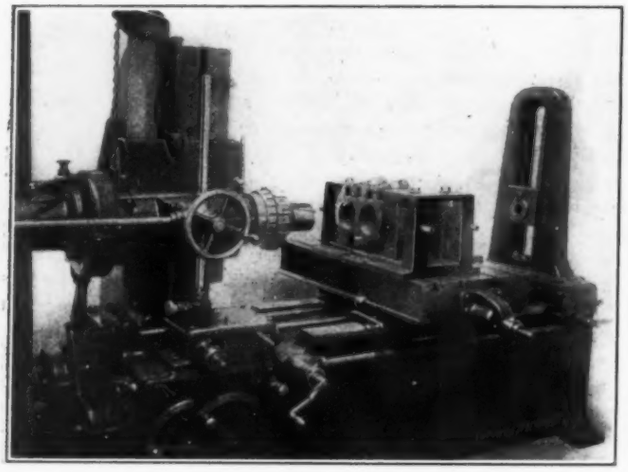


FIG. 4. BORING FIXTURE FOR CYLINDER OF AMERICAN SIMPLEX 2-CYCLE MOTOR

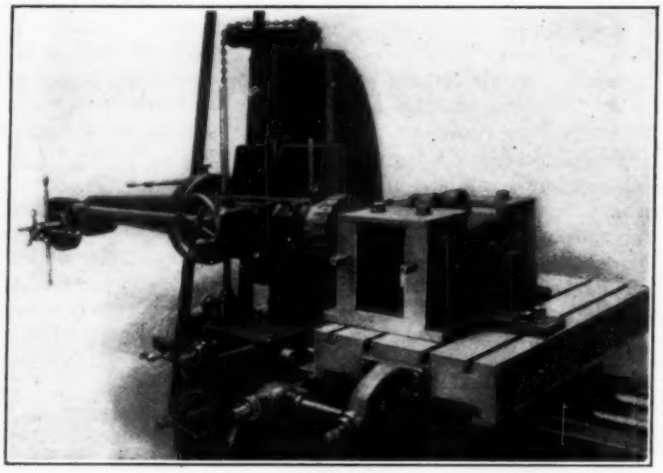


FIG. 5. AMERICAN SIMPLEX 2-CYCLE BORING FIXTURE SHOWING LATCH

it from the bell chuck and bolt the piston open end to an angle plate on the flat turret face plate and bore and ream the piston pin hole. The time required is 60 minutes.

The fifth operation is to chuck the piston open-end on a hub on a shouldered plug in the flat turret spindle, and hold the piston by a long screw passing through the hollow spindle and tapped into a short pin in the piston-pin hole, so as to leave the whole outer surface of the piston exposed; then turn the whole piston-body cylindrical surface to a grinding diameter with a straight cut, leaving it 0.01 over the piston-bore diameter; time 60 minutes.

The sixth operation is to rough groove the piston ring seats with a gang of four grooving tools at one setting; time 35 minutes.

At the same setting is performed the seventh operation. The piston outside head, central boss is centered. This boss is afterward removed so that the top of the piston head is finally left smooth; time 2 minutes for this centering operation.

The eighth operation, on an engine lathe, is to put a centered flanged plate in the piston open end and put the piston on centers with a face-plate drive against the piston integral-deflector and finish groove the ring seats with a 4-cutter gang; time 6 minutes.

Ninth operation, place the piston on the grinding-machine centers and grind to finished diameters, on a small Landis grinding machine; time, 25 minutes.

Tenth operation, remove head center-boss with a hack-saw, and finish the head

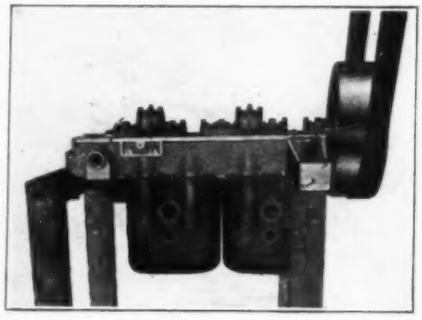


FIG. 8. AMERICAN SIMPLEX 2-CYCLE MOTOR FINISHING

and the deflector by hand with a file, scraper and emery cloth; time 300 minutes.

The piston-pin screw-seating and the ring-stud seating are not considered here, as these operations vary much in the practice of different constructors and are wholly omitted in some instances.

The time required for the actual "running in," shown in Fig. 8, is about 480 minutes, the cylinder bores being wiped and examined from time to time as the "running in" proceeds.

The length of the cylinder bore touched by the piston is 12 5/16 inches, diameter 5 inches. Total cylinder boring, facing and grinding time is about 629 minutes for each cylinder dual unit.

The machining and grinding time for one piston is about 508 minutes.

Shortly after the Chino-Japanese war the latter government started the practice of sending abroad students and others who have shown exceptional ability or aptitude for the purpose of studying industrial and commercial conditions in the foreign countries and learning methods, means and ways of production and organization that are likely to be of value in the industrial development of Japan. The practice has met with such success as to lead to considerable increase in it as is shown by the fact that in 1896 there were but 12 such agents in foreign countries, whereas in 1906 there were close to 100 progressively studying abroad in the interests and pay of their government, since which year the practice has been steadily followed.

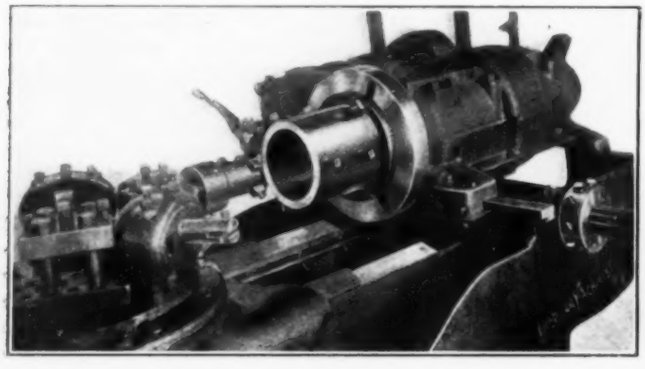


FIG. 6. AMERICAN SIMPLEX 2-CYCLE MOTOR PISTON FINISHING

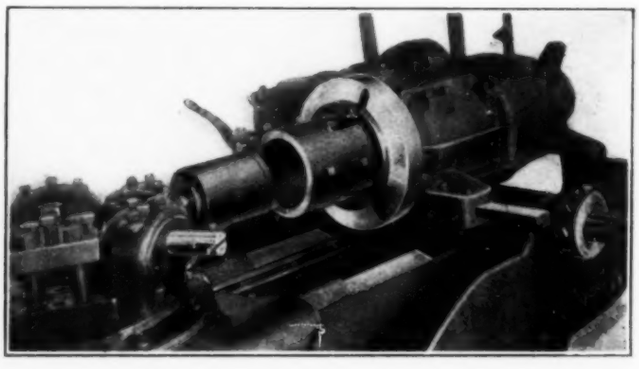


FIG. 7. AMERICAN SIMPLEX 2-CYCLE MOTOR PISTON FINISHING

A Pair of Odd Shaped Gears

When it comes to gears that are different from anything in Hoyle or elsewhere, the printing-press designer has all the rest of the mechanical men left at the post. Here are a pair used in the Coy press and they had to be cut on regular milling machines in the shop. That it took careful designing and laying out is self-evident, and the fact that the pitch circumference came within 0.003 of being the same in both gears shows how carefully the work was done. This was accomplished by Mr. Andrew Strom, now of the Dayton Pneumatic Tool Company, Dayton, O., who planned it so no filing or fitting was necessary. This meant that the irregularities not only had to match each other, but be divisible by the circular pitch of the teeth.

The Type-cylinder Gear

This gear, Fig. 1, is practically a round spur gear except for the two flat sides, and while it is not difficult to machine, it combines a spur gear and a rack in a way that is not pleasing to the gear-cutting department of a shop.

The teeth are 0.6 pitch, pitch diameter, 20.166, and a total of 120 teeth. The teeth were cut from the four quarters, with a tooth in the center and 21 spaces each side on the round portions, and nine spaces each way on the flats.

This was cut by compound-index moves, set for 121 teeth, indexing from the two points for the teeth *on the opposite side of the blank*. Using both 47 and 49 circle holes, move crank 1 14/47 turns right-hand and then backward 15 holes in the 49 circle, or 1 14/47 — 15/49. Or a special plate of 121 holes could be used, moving 40 holes for each tooth.

Cutting Gear for Impression Cylinder

In cutting the teeth on the gear for the impression cylinder, Fig. 2, it was necessary to swing it from three centers, the main center for the regular portions of the gear and the two side centers for the smaller portions at each side, and the indexing became quite a difficult proposition.

The indexing was not continuous, but was started from four points, at the centers of the four arcs, with the tooth cut in the center, as shown.

It took some careful calculating to find just what to do but it was finally worked out to index in compound as follows: Three turns + 25 holes in the 47-hole circle, then 12 holes in the 49-hole circle in the same direction, giving 3 25/47 + 12/49 for each tooth.

After the center tooth was cut, 21 teeth were cut on each side of it, bringing the teeth to the beginning of the smaller radius. Then the blank was shifted to either end center and the center tooth cut on this portion, then eight each way. This meets the other cutting, leaving the sharp-pointed tooth shown.

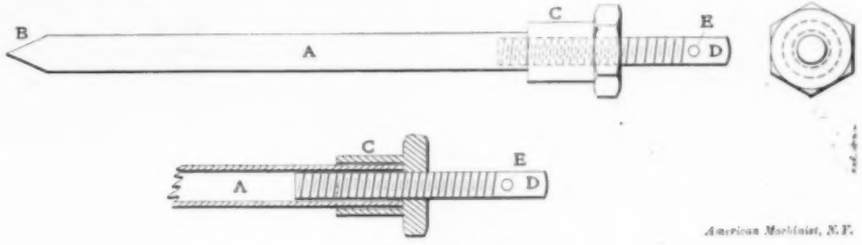
This indexing is the same as for 60 teeth, but only 17 are cut in all. A No. 2 cutter is used, being, of course, the same for all teeth, and is equivalent to a 6-pitch on the normal part of the gear.

The indexing could also be done with a special plate having 233 holes and moving the index pin 80 holes for each cut. This worked out perfectly for this gear.

A Planer Brace

By M. F. Parsons

The accompanying cut shows a useful jack or brace for the planer, boring mill, etc. The part marked *A* is a piece of ordinary 1¼-inch pipe flattened at *B*. *C* is a nut which fits over the pipe *A* as shown in the sectional view. *D* is a piece of 1-inch round steel threaded and drilled at *E* for the purpose of adjusting its length. By having an assortment of lengths of pipe *A* one can quickly and conveniently select a brace to suit the occasion. The nut *C* and rod *D* remain together and may be inserted into the pipe end at will.



A PLANER BRACE

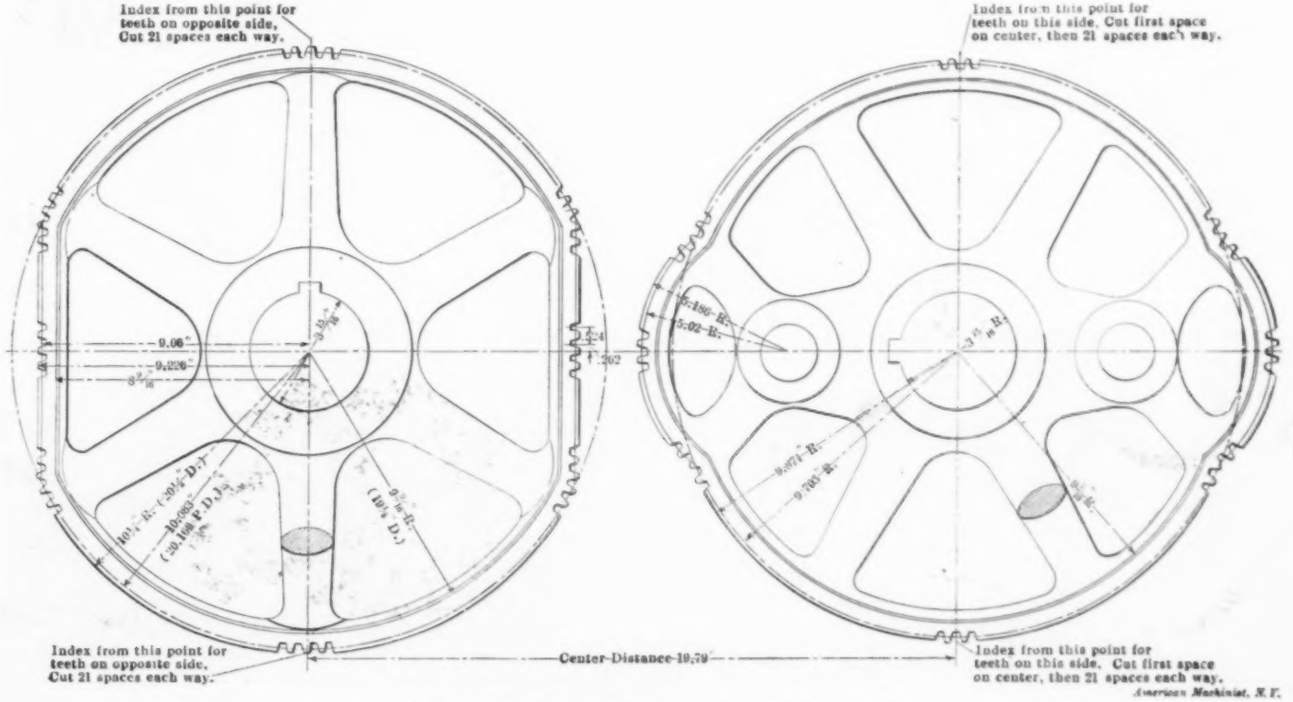

Index from this point for teeth on opposite side, Cut 21 spaces each way.
Index from this point for teeth on this side. Cut first space on center, then 21 spaces each way.
9.06"
9.226"
Center-Distance 10.79
Index from this point for teeth on opposite side, Cut 21 spaces each way.
Index from this point for teeth on this side. Cut first space on center, then 21 spaces each way.
American Machinist, N.Y.

FIG. 1 A PAIR OF ODD SHAPED GEARS AND HOW THEY WERE CUT FIG. 2

Modern Iron Foundry and Materials Yard

Covered Material Yard, Coke and Sand Bins, Outside Firing of Coke Ovens, Transfer Track and Truck for Charging Cupola, Heating System

EDITORIAL CORRESPONDENCE

The Nordberg Manufacturing Company, Milwaukee, Wis., has recently built a large iron foundry that contains many interesting features for facilitating the handling of the materials and castings.

An idea of the size and general construction of the foundry building proper can be obtained from Fig. 1. The foundry has a steel frame with brick side walls, and light is admitted through roof and side-wall windows. The main bay has an 80-foot span and is served with two cranes, one of 80 tons capacity and the other 60 tons. These cranes, as well as the others, were supplied by Pawling & Harnischfeger.

The bay to the left has a span of 80 feet, runs the whole length of the building, and is served with two 60-ton cranes. Four large and four small doors are located in this side of the building, and through these the flasks are brought, as the flask yard is located just outside. The flask yard is served with a single-leg Gantry crane for the purpose of handling the flasks and bringing them into the building where they can be picked up by the inside crane. The flask yard and crane are shown in Fig. 2.

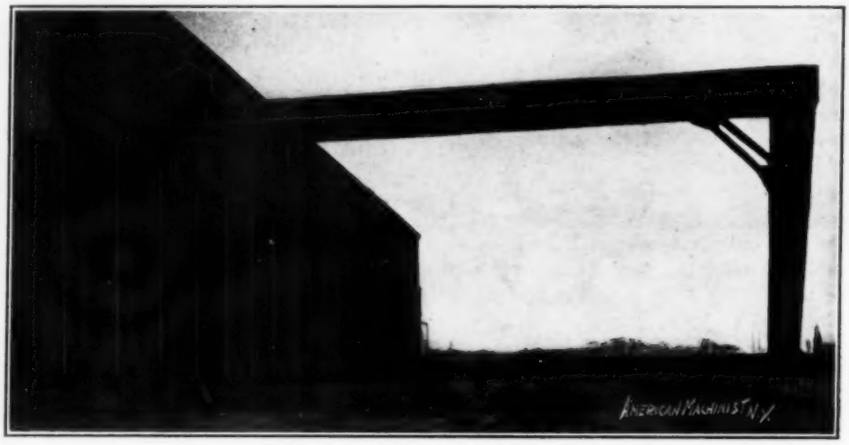


FIG. 2. SINGLE LEG GANTRY CRANE FOR SERVING FLASK YARD

The bay to the right of Fig. 1 has a 70-foot span and in the center of it are located the cupolas, blowers, engines, and ventilating and heating apparatus. These are all located in a room by themselves. At the rear end of this bay are located the tumbling barrels, benches for making small cores and the small core ovens. It is served with a 20-ton traveling crane with a 5-ton auxiliary. In the far end of this bay are located the large core oven

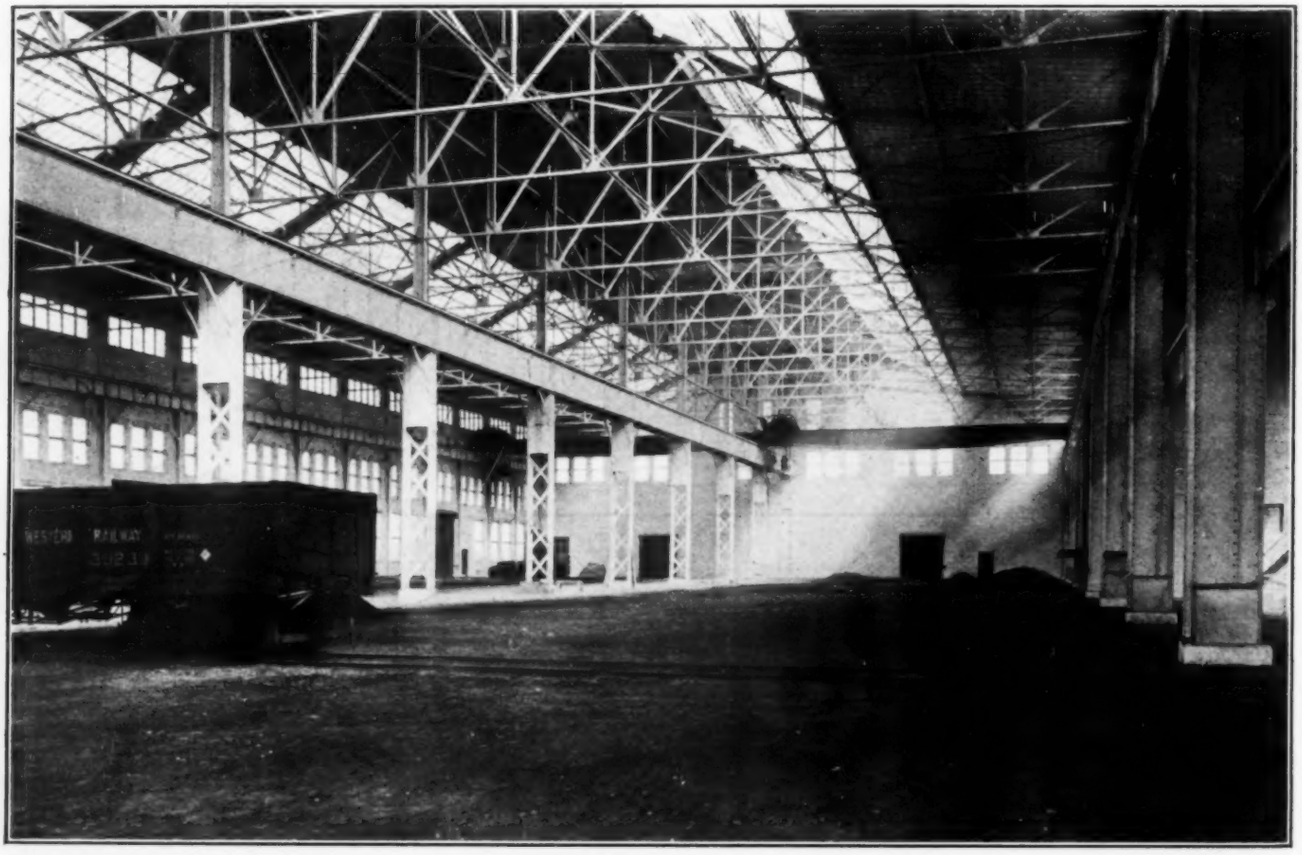


FIG. 1. TWO MAIN BAYS OF FOUNDRY, EACH HAVING AN 80-FOOT SPAN, BAY TO RIGHT 70 FOOT

FIG. 5. SAND AND COKE STORAGE BINS, TRANSFER CAR SCALES AND CUPOLA CHARGING CAR

and the coremakers' floor. On the ground floor and back of the cupolas is located the wash room, supplied with hot and cold water, soap and towels, and steel clothes lockers.

At the far end of the building is located a large room that will be used for storing patterns, tools and supplies that are being used in the foundry. The foundry foreman's office is also located in this end of the building, and these rooms are separated from the main floor of the foundry by rolling steel doors, such as are shown in Fig. 3.

Materials Yard

On the right side of the foundry proper is located the materials yard, and this is covered with a roof that extends out from the main building of the foundry for its whole length, as shown in Fig. 4. This yard has a width of about 80 feet, and is served with a traveling crane. A railroad track is located outside the posts which support the roof, and another track is located inside so that cars can be brought under the roof and loaded or unloaded without storms interfering with the workers while they are handling the material.

At one end of the yard are located bins for storing the sand and coke, and these are loaded into the bins from the railroad cars; while on the opposite side, that is, the side near the foundry, the materials are taken out for use. Next to these bins is piled the scrap iron and next to that the pig iron.

The foundry side of the bins is shown in Fig. 5. The openings to the bins are built in such a way that as the material lowers inside of the bin, boards can be

FIG. 4. COVERED YARD FOR STORING THE MATERIALS USED IN THE FOUNDRY

taken out to enable the men to handle the material easier, while at the same time, when these boards are all in and the bins full, no sand, coke or other material will run out.

A car on which is located platform scales, runs the whole length of the materials yard, and the car for handling the material is run on this, as shown in Fig. 5.

FIG. 3. ROLLING STEEL DOOR

The material is loaded in, weighed, and then taken to the various places for use. This is especially useful when charging the cupola, as every pound of material that goes into the cupola can be easily weighed before it is taken to the charging room.

In Fig. 6 is seen the lower end of the materials yard, and this shows a pile of

FIG. 6. FIRING PIT FOR CORE OVENS, CHARGING FLOOR EXTENSION, STOCK PILES, 5-TON STOCK-YARD CRANE WITH 80-FOOT SPAN

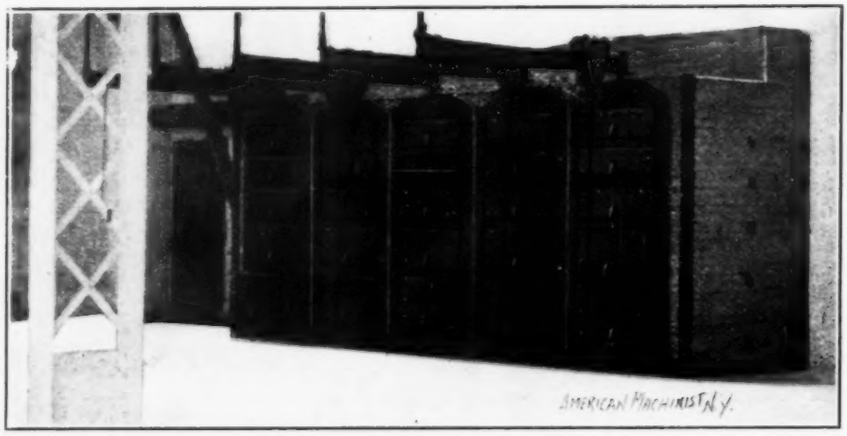


FIG. 8. OVENS FOR DRYING SMALL CORES

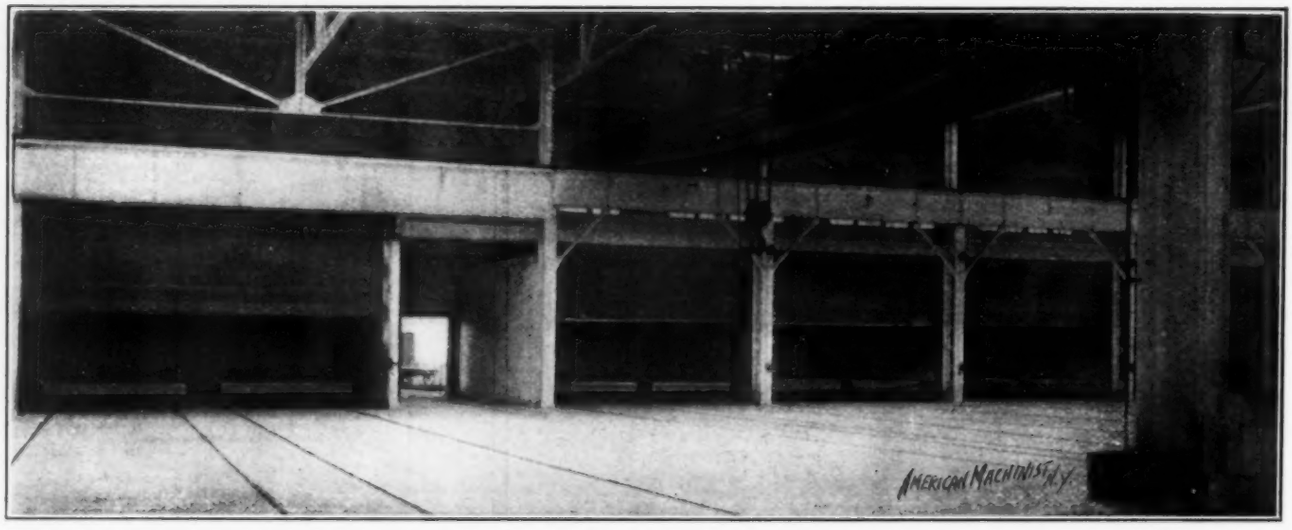


FIG. 7. OVENS FOR DRYING LARGE CORES. 20-TON CRANE WITH 5-TON AUXILIARY AND 70-FOOT SPAN

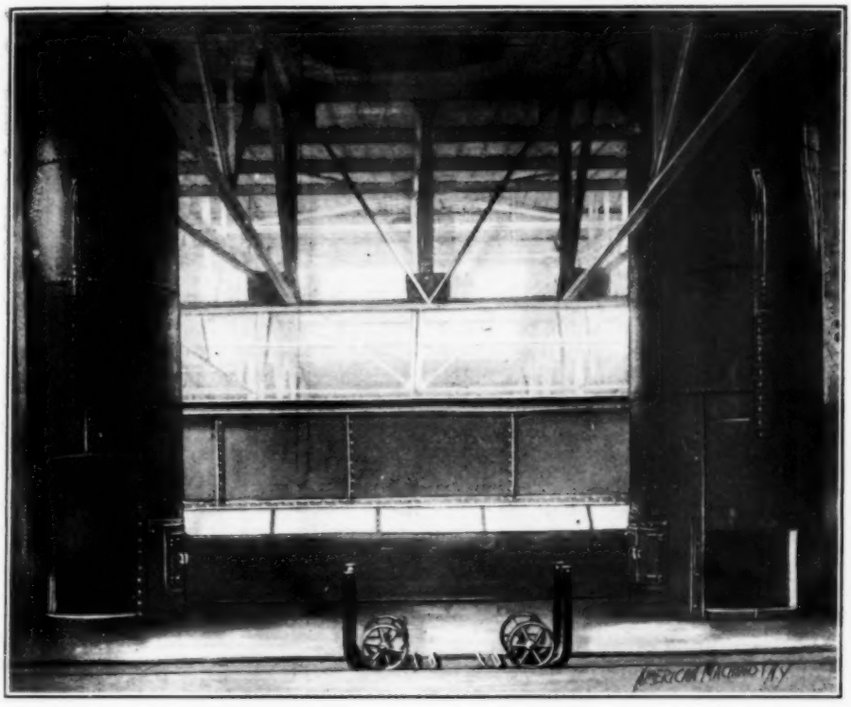


FIG. 9. GRANITE-TOP CONCRETE FLOOR. TRANSFER TRUCK FOR CHARGING CAR

pig iron and scrap on the left-hand side. The track and the turntables coming out of the foundry are not yet completed, as they will be extended across to the yard track so that the charging cars can be run across and onto the platform scales.

Core Ovens

On the right side of this halftone is shown a long pit next to the building. From this pit the fires extend under the core ovens, on the inside of the building, and the firing is done from the outside. This enables the material used for the fires to be handled easily and also keeps the dust and dirt of the firing outside of the foundry. Over the firing pit is seen a long pipe, through which a force draft carries the smoke and gases away from the core-oven fires.

In Fig. 7 are shown the core ovens which are heated by these fires, and in front of the ovens is located the coremakers' floor. This floor is covered with steel plate, while all the rest of the foundry has a dirt floor. Over the oven is located a mezzanine floor which can be used for storing the various materials used by the coremakers. The coremakers' floor is served by a 20-ton crane with a 5-ton auxiliary. The ovens for the small cores on the opposite side of the cupola are shown in Fig. 8.

Cupolas

At the far end of the firing pit in

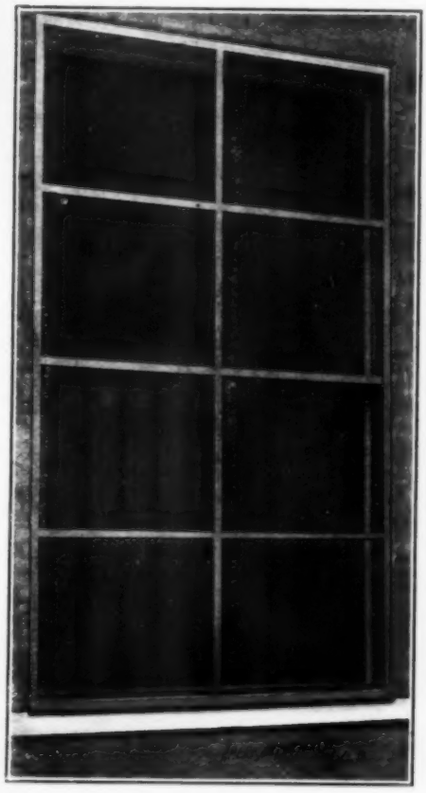


FIG. 11. COLD-AIR INTAKE FOR HEATING SYSTEM

Fig. 6 will be seen an extension of the charging floor. Here the materials for charging the furnace will be brought across a track (not yet laid) in the charging car, run onto an elevator and elevated to the charging floor.

The charging car has wheels with an extra wide rim, one-half of which is flat, for running on the cement floor, while the other half is flanged for running on its track. The charging floor, as shown in Fig. 9, has a track running across it, in front of the furnaces, on which runs a truck that will hold the charging car. When the charging car is on this truck it can then be transferred across the room to either of the furnaces. As will be seen, arrangements have been made to install a third cupola when it is needed.

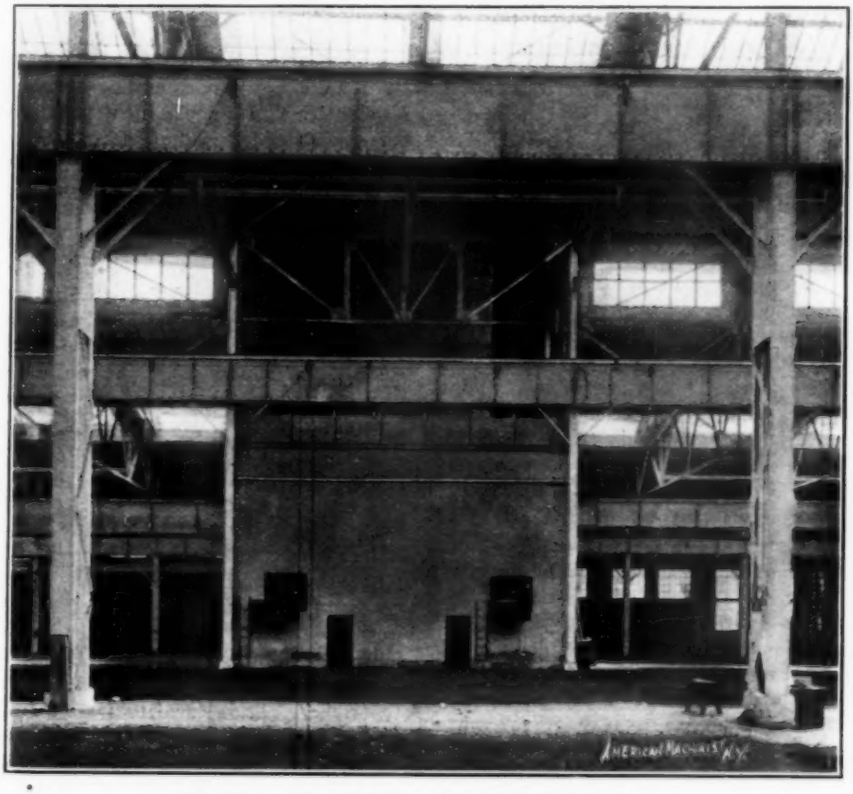


FIG. 10. THE CUPOLAS FROM THE FOUNDRY FLOOR

In Fig. 10 is shown the front of the cupola from the foundry floor. The bottom of the cupolas are walled in with brick to keep the heat away from the foundry floor, and when the bottoms of the cupolas are dropped the dirt and dust are also kept out of the foundry. The small core ovens will be seen to the left of the cupolas, as the large core ovens are to the right.

Heating

The foundry is heated by a hot-air system. The fresh air is taken in through the opening, shown in Fig. 11, which is located on the material-yard side of the foundry so that it is under roof, and no snow or rain will come through. From here the air is passed through the pipe coil shown inside of the window and conveyed across the foundry by underground tunnels.

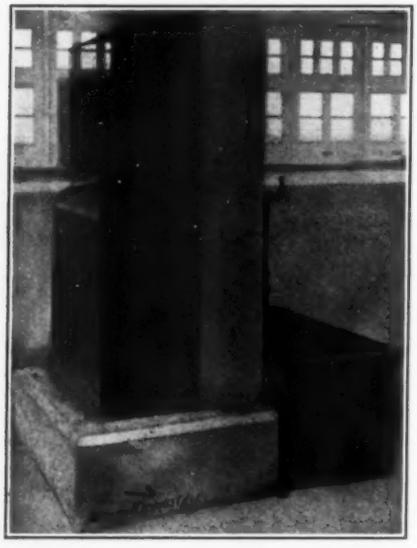


FIG. 12. OUTLET FOR WARM AIR AND WATER TANK

These tunnels have openings at the pillars throughout the foundry that are protected by steel boxes and wire screens, as shown in Fig. 12. As said before, cold air can be put through the same system to cool the foundry in warm weather. On the opposite side of the pillar from each heat duct is located a cast-iron water tank with running water, so that the molders can easily obtain a supply of water for wetting down their sand.

The principal product of this foundry will be large castings, and every means have been adopted to facilitate the handling of the castings and the materials for making them. A railroad track goes through the end of the foundry that will be used for cleaning the castings so they can be loaded on cars for shipment or conveyance to other parts of the plant. The building has been made as nearly fireproof as possible.

Sizes of Pipes without Mathematics

By Walter R. Clark

Having considerable work to do in connection with a high-pressure hydraulic plant, among the first things that came up for consideration was the loss due to friction in various sizes of pipe for different velocities of flow. High-pressure water necessitates the use of extra or double-extra heavy pipe and fittings which are much more expensive than the standard weight, but the use of higher velocities of flow in the pipe line is allowable whereas those used for low-pressure water, owing to the fact that the per cent. of power lost in friction for any given velocity decreases directly as the pressure increases. The coefficient of friction is independent of the pressure, but dependent upon the velocity of the flow and the size of the pipe.

An examination of several tables given in the standard engineering pocket books for friction loss in pipes disclosed the fact that they did not include values for high velocities. The formulas given were found cumbersome to use, so we finally adopted the tables of "Ellis and Howland" as giving a greater range of values than most of the others. These tables, based on actual experiment, proved to be most suitable for the work at hand. Inspection of them soon showed that for velocities above 3 feet per second the friction loss in every case increased about 32 times by halving the pipe size. This fact indicated that the relations between the diameter of pipe, the quantity discharged, and the friction loss could be represented by straight lines on logarithmic cross-section paper.

After some preliminary trials we adopted as coördinates the quantity discharged in gallons per minute and the friction loss in pounds per 100 feet of straight pipe, and plotted lines on the chart representing the different diameters of pipe. These lines for velocities above 3 feet per second were straight lines, so that we felt justified in extending them for velocities beyond the limits of the tables given. There are so many minor factors which affect the friction loss, such as variation in exact diameter of pipe and condition of surface, that a 3-per cent. error in the table would be of no practical importance in the use of the chart. Having plotted the pipe sizes, we also plotted the lines of equal velocity on the chart. These were also straight lines at right angles to the pipe-diameter lines. The equations which were satisfied by the chart are worked out as follows:

Let

Q = Quantity discharged in gallons per minute,

V = Velocity in feet per second,

D = Inside diameter of pipe,

F = Friction loss in pounds per 100 feet of clean, straight, iron pipe.

Then

$$Q = \frac{\pi D^2 \times 12 \times 60\, V}{4 \times 231} = 2.46\, V D^2,$$

and

$$F = \frac{0.18\, V^2}{D} = \frac{0.03\, Q^2}{D^5}.$$

The values of F are approximately true for V greater than 3.

The chart has proved of considerable assistance in laying out pipe sizes for hydraulic mains and branches. As will be seen, I have interpolated lines representing the actual size of standard extra heavy (X) and double extra heavy (XX) pipe. Scales have also been plotted on the left for loss in head and at the top for velocities in cubic feet per minute.

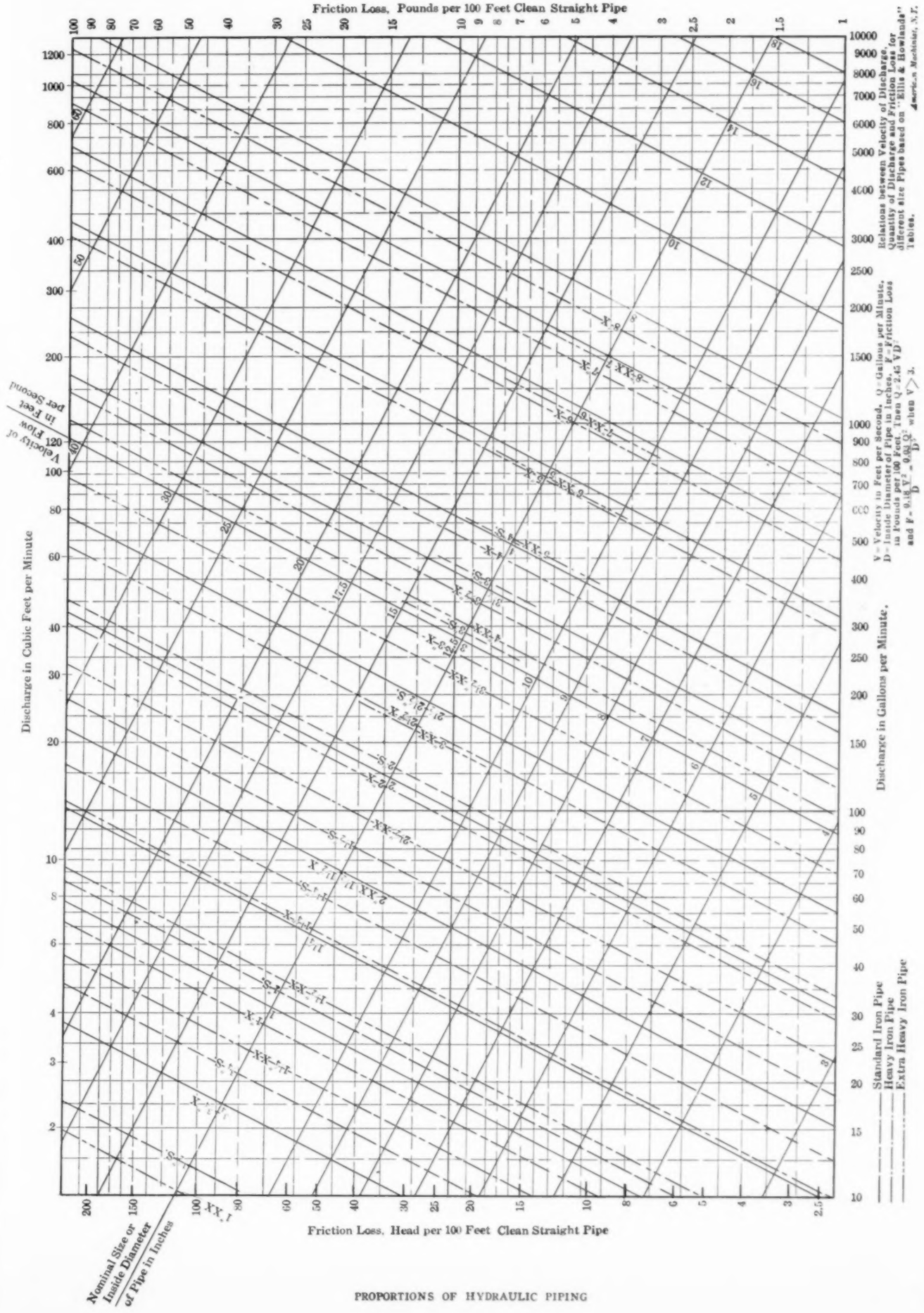
Illustrative Example

As an illustration of the use of the chart, assume that 200 gallons per minute are to be transmitted a distance of 500 feet with an allowable pressure drop of 50 pounds. This gives 10 pounds drop per 100 feet. Now, following up the vertical line of 200 gallons per minute, and across the horizontal line representing 10 pounds per 100 feet, their intersection is found about half way between the full diagonal line representing 2½ inches diameter and the next one representing 3 inches diameter, showing that a pipe about 2.6 inches inside diameter would be required. If extra-heavy pipe sizes are to be used the 200-gallon line intersects the 3-inch X pipe line at 7½ pounds pressure drop per 100 feet, and the 2½ X-pipe size at 17½ pounds per 100 feet. The intersection of the former lies almost exactly upon the diagonal line of velocity marked 10 feet per second, which is the velocity of flow if the 3-inch X pipe is used. If the 2½-inch X pipe is used, the velocity is seen to be 15 feet per second.

Another way to use the chart is when a pipe size and velocity are given. We then find the intersection of the two diagonals representing pipe size and velocity and read down from their intersection to get gallons per minute; up to get cubic feet per minute; to the right to get pounds pressure drop per 100 feet of pipe, and to the left to get pressure drop in feet (head) per 100 feet of pipe.

It seems scarcely necessary to state that these friction losses given do not include loss of head due to water flowing into the pipe from another vessel, but simply represent the loss in a section of straight iron pipe through which the water is flowing at the velocity given.

It has been found that the friction due to ordinary ells is equal to from 8 to 12 feet of straight pipe, so that the table may be used in cases where fittings occur by considering them as equal in friction to just so much more pipe.


Friction Loss, Pounds per 100 Feet Clean Straight Pipe
Velocity of Flow in Feet per Second
Discharge in Cubic Feet per Minute
Discharge in Gallons per Minute.
Friction Loss, Head per 100 Feet Clean Straight Pipe
Nominal Size or Inside Diameter of Pipe in Inches
Standard Iron Pipe
Heavy Iron Pipe
Extra Heavy Iron Pipe
Relations between Velocity of Discharge, Quantity of Discharge and Friction Loss for different size Pipes based on "Ellis & Howlands" Tables.
American Machinist, N.Y.
V = Velocity in Feet per Second. Q = Gallons per Minute.
D = Inside Diameter of Pipe in Inches. F = Friction Loss in Pounds per 100 Feet. Then Q = 2.45 VD²
and F = 0.02 D / D² when V > 3.

The Transmission of Power by Ropes*

Individual System and Three Strand Cotton Rope Preferred over Continuous System and Manila Rope—Horsepower Factors, Pulleys, Etc.

BY EDWARD KENYON

Originally, when rope transmission was in its infancy, when its capabilities were less understood than now, and before cotton supplanted harsher fibers in the manufacture of ropes, spur gearing was looked upon as the standard of both efficiency and economy. The rope drive was merely tolerated, not because it presented any pecuniary advantages, but on account of its being less noisy and cumbersome, from the fact that with it there is neither grind nor backlash, and heavy shafts are not necessary to convey the powers to the various stories of a mill. It was thought that rope driving was the greatest sufferer from frictional losses, which belief was maintained with great persistency, though the actual amount of these losses was estimated within a wide range. From 7 to 10 per cent. was, however, regarded as a fair valuation.

When compared with belts, ropes have some distinct advantages, one of these being that, with the latter, creep or slip is much less, and the drive is more positive. The existence of this quality has been proved by expert tests taken at a cotton mill in the Manchester district where ropes had taken the place of belts for driving ring spinning frames by means of fast and loose pulleys. The groove action of rope pulleys also acts in opposition to centrifugal force, which latter is so potent a factor in belt driving. Ropes can, therefore, be run at a much higher velocity than belts. Few cases of rope transmission exceed a velocity of 5000 feet per minute, presumably because of the necessity for specially constructed pulleys; but such as do, totally disprove the theory of centrifugal detractions at high velocities; nay, rather reveal a larger ratio of increase than the figures declare. There are cases of ropes running satisfactorily which have a speed of over 7000 ft. per minute. A recent report from the engineer of a rope drive in Scotland suggests an easy transmission of 100 horsepower for 1½-inch ropes at 7000 feet per minute, and also volunteers the opinion, based upon a wide experience of rope driving, that at this velocity the ropes will last quite as long as when running at 5000 feet per minute.

All things considered, the only workable corollary to any proposition directed toward the solution of this question appears to be that of fixing upon such a formula as will provide an ample, though not extravagant, margin of safety against collapse to individual ropes in fair sized installations, and that shall not exceed the capacities of a good quality of rope, giving to superior makes the benefit of extended durability. In the absence, therefore, of finer adjustment, the table annexed is now submitted with the greatest confidence, seeing that it conforms to the regular findings of engineering practice.

Thus, following down the column of figues under 1¾ inches in diameter, it will be found that the ratio of power is represented as 10 horsepower for every 1000 feet per minute. Therefore we have but to take off the two terminal ciphers in the velocity column and the remainder is the progressive power, which finishes at 70 horsepower for 7000 feet. These columns, although equally progressive, are based on comparative sectional areas. It will be observed that mention is made of good three-strand cotton ropes. The reason for this distinction will be given when dealing with the question of make and material.

With regard to the relative cost of ropes and of belts, practical experience has shown a very great advantage in favor of the former, and the advantage is more marked in the case of thin ropes, say ½ inches in diameter, such as are used for driving light machinery, like ring spinning frames.

Rope driving may be said to be divided into two systems, known as the American, or continuous system, and the English, or undivided system; and if these be examined, the relative value of each in its effect on the general principle involved will be understood, not simply by theoretical deduction, but by practical experience.

The Continuous Rope System

The continuous or American rope system—viz., that of winding one long rope as many times round driving and driven pulleys as there are grooves to fill, and carrying it across the whole width of both by means of a "sliding" jockey pulley sustained at the required angle—may possess certain advantages under special conditions, as, for instance, the driving of paper-making machinery by a series of expanding rope pulleys so arranged as to permit a variation at the driving line of about 4 inches in their respective diameters. But under the ordinary conditions governing power transmission the comparative imperfections of the method are so pronounced that numerous installations have been transformed to multiple ropes, with most beneficial results.

One typical undertaking will doubtless suffice to exemplify the causes which lead to similar transformations. When first erected, a large installation of grain elevators was driven by continuous manila ropes (fitted up by the American firm who supplied the machinery) from a main shaft receiving its power through multiple cotton ropes from two pairs of compounded engines, thus affording excellent tentative conditions.

The most noticeable feature in the working of the continuous drive was the irregular rope tension. The trailing span appeared to reach its highest tension immediately after leaving the "jockey," and gradually to slacken down with every succeeding lap of the pulleys until the circuit was completed, repeating the operation so long as rotation continued. Similar irregularities may be observed in continuous vertical drives, with the exception that the slack falls away in corresponding gradations from the bottom of the lowest pulley.

The strain consequent upon attempting to regulate the tension by a weighted carriage attachment, lateral pressure upon the grooves due to deflections from the straight driving path, and other influences, soon told upon both durability and efficiency. Separate cotton ropes were gradually substituted for continuous manila, until the original cumbrous system almost entirely disappeared. Another great detriment to the general adoption of continuous driving is that of having to place dependence upon one splicing and the entire stoppage of a drive in the event of collapses until the tedious process of replacement is completed; whereas with "multiple" driving, a good reserve of power being generally allowed, an accident to one of the ropes means only running without it probably for the remainder of the day.

Casing of Pulleys

An important consideration often omitted when arranging for rope driving is the casing the sides of pulleys with sheet metal or boards, without which the displacement of air by the arms of large high-speed pulleys adds materially to the profitless load. In the absence of data from which to ascertain the starting point of economy by such arrangements, it may be as well to submit the opinion of three well known engineers who have had considerable experience in rope driving. One firm recommends the casing of all pulleys,

*Condensed from paper presented to South Wales Institute of Engineers.

small or large, on the ground that by so doing a saving of 50 horsepower in 1000 may be effected. Another advocates casing pulleys 7 feet in diameter and overrunning at a peripheral velocity of not less than 4000 feet, while still another firm advises casing all sizes, but declares economy to be noticeable on large high-speed pulleys.

Minimum Diameter of Smallest Pulley

The item which appears most naturally to offer itself first for consideration in our specification is the bending and consequent gripping capability of the rope itself. Soon after cotton came into use for main driving ropes it was discovered that a three-strand rope of this material would cling firmly to a pulley 30 times its own diameter, but would gradually relax its hold as the relative diameter decreases from this standard. Subsequent practice places the validity of this conclusion beyond the possibility of doubt.

Proportionate Durability of Ropes on Large and Small Circumferences

Too much importance can scarcely be attached to the relative proportions of pulleys and ropes, for it is absolutely certain that both driving force and durability suffer most materially from the nonobservance of the 30-diameter regulation, and that nothing, not even space restriction, has gone so much against the successful application of ropes to the driving of dynamos, or transmission from high-speed motors, as a persistent effort to get below this natural limitation. Therefore, instead of adding to the burden of the drive by employing an abnormal quantity of thick ropes to make up for grip depreciation when large pulleys prove impracticable, it is far better to divide the total bulk nominally required into the necessary number of smaller ropes.

Arc of Contact

Before dismissing the consideration of pulley diameters it will be well to notice another phase of the same question, viz., that which deals with the arc of contact. It needs but little reasoning to prove that rope contact reaches its maximum when both pulleys are equal in size; but when unequal the utmost quantity realizable is that carried by the smallest pulley, whether it be driver or driven. The full value of this assessment however, also depends upon center distances, as may be readily inferred by reference to the two diagrams, Figs. 1 and 2. With the two circles farthest apart it will be seen that the arc of contact secured to the smallest one is 157 degrees, while with the circles at close quarters the arc of contact is reduced to 125 degrees, making a difference of 32 degrees between the two positions.

Short Centers

For evidence of the fact that by adding sufficient rope to make up for deficient contact driving may be successfully accomplished when pulleys are almost touching, we need only refer to this reproduction of an engine in Dundee, Fig. 1, from which spur gear was removed and rope pulleys fixed upon the same centers, permitting a clearance of only 8 inches between the rims, 360 horsepower being thus comfortably transmitted with 16 ropes 1¾ inches in diameter. At a mill in the North of France the pulleys are so close that a finger would scarcely pass between them.

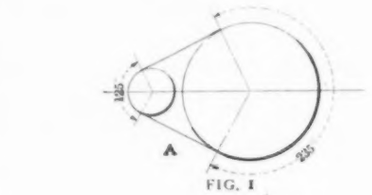


FIG. 1

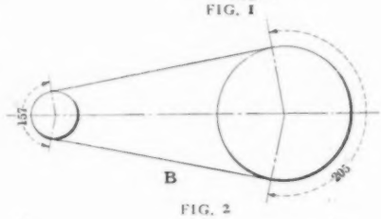


FIG. 2

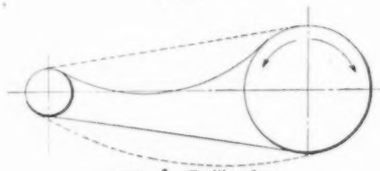


FIG. 3. Trailing Span

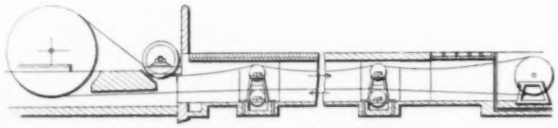


FIG. 5. Sustaining Pulleys at Unequal Distances

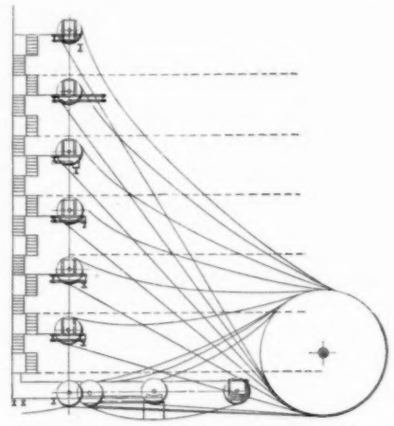


FIG. 4. Long Centers (Ordinary Mill Drive)

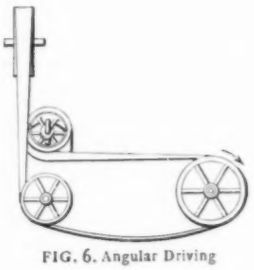


FIG. 6. Angular Driving

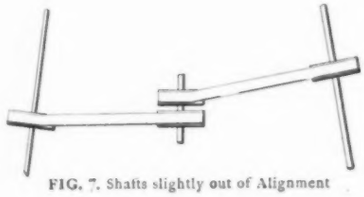


FIG. 7. Shafts slightly out of Alignment

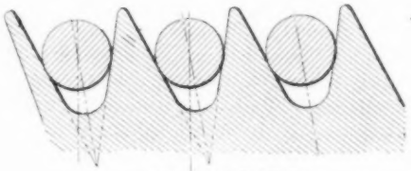


FIG. 8. Tilted Grooves

FIG. 9. Showing Direction of Rope

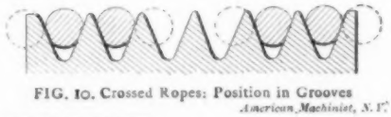


FIG. 10. Crossed Ropes: Position in Grooves

American Machinist, N. Y.

DIAGRAMS AND DETAILS OF ROPE DRIVES

Trailing Span of Ropes

The arc of contact is also affected by the position occupied by the trailing span of the ropes, which, when above the pulleys, undoubtedly gives the maximum bearing surface. This position is not always attainable, nor is it in all circumstances desirable. For example, an erratic delivery of power or variable load may set up oscillations in the responsive ropes of such violence as to fling them entirely off the pulleys. Now if the direction of rotation is so arranged as to bring the trailing span below the pulleys, any tendency on the part of the ropes to wander from their appointed track is held in check by the pull on the tight side, while gravitation tends to control the vibrations on the slack side.

Loss due to reverse driving may for safety be calculated as the difference between the average of 170 degrees, acknowledged in the table of horsepowers, above, and the arc of actual contact, which is usually measured from the tangent point of a curve whose depth (from a straight line drawn along the bottom of the pulleys) is one-tenth that of the distance from center to center of the shafts and the taut portion of the rope stretched across the top of the pulleys. This diagram, Fig. 3, presumes upon the horizontal position. With oblique driving the same tendencies do not prevail.

Long Centers

The contiguity of rope pulleys just mentioned gives rise to suggestions bearing

upon the opposite extreme; that is, as to the greatest distance at which power may be transmitted with unsupported ropes. Again, referring to the diagram, Fig. 3, it will be readily observed that in under-driven installations center distances are governed by the size of the pulleys employed, and should allow sufficient clearance between the ultimate slack of the trailing span (viz., 10 per cent. of the centers) and the tight portion of the ropes. Over-driven installations obviously permit a greater latitude, and centers may be—in fact are—pretty successfully extended to distances of over 100 feet without intermediate support. In lengthy drives of this sort it is, however, necessary to provide against the extra strain imposed by the actual weight of the ropes by strengthened shafts and bearings. Should the distance prove too great for one span, rather than merely sustaining the ropes midway, it is far better to divide and drive forward from intermediate pulleys. Center distances in ordinary mill driving seldom exceed 90 feet, and these are usually fixed in an oblique direction, as represented in Fig. 4.

Sustaining Pulleys Fixed at Unequal Distances

In cases where sustaining pulleys are found necessary, it is always advisable so to distribute them along the drive that the intervals between the centers shall not be equal.

The sketch of a tunnel drive at a large timber works in Scotland, Fig. 5, represents one of the best examples of this class of driving known to us, and well explains the reason for such inequalities. The center distances in this instance read as follows: From flywheel to pulley-deflecting ropes into the tunnel 16 feet from this to the first set of sustaining pulleys, 15 feet 6 inches, between these and the second set, 29 feet, and from the second set to the driven pulley at the far end of the tunnel, 22 feet. The oscillations due to starting the engines, or the sudden removal of the entire load of 225 horsepower, are thus anticipated; and the possibility of synchronization along the whole track is entirely obviated by altering the length of the beat and breaking up the rhythm to such an extent that the initial wave-like movements quickly diminish to mere rippling disturbances. On this account the ropes have never been known to leap the grooves.

Angular Driving

There is no class of power transmission which lends itself better to the treatment of what may be considered awkward conditions than rope driving. With the aid of guide pulleys any angle may be negotiated or corner-turned. But as it is impossible to cover all the varied conditions which accost the engineer, one or two suggestions may point the way to the solution of other similar difficulties. When transmitting power to shafts set in an angular position, whether resting upon the same plane or whatever position or angle they may assume in relation to each other, the tight side of the rope should be directed by the pulley deflected to a suitable angle, while the slack is carried by the one revolving upon the horizontal axis, as shown in Fig. 6.

Corner Driving

What may be designated corner driving is accomplished by means of guide pulleys rotating freely—that is, allowing sufficient play to follow the slack either up or down—upon a vertical shaft. The grooves of such guide pulleys require to be turned deeper than ordinary, or the ropes may fall away. A much better way, however, is to extend the shafts so that the guide pulleys may be used in the same manner as for angular driving.

Guide pulleys, as a rule, are made too small for the ropes they have to carry, and on that account they (the ropes) suffer considerably from overstrain in passing sharp curves.

As already stated, the hurt to a rope is due more to the bending than the driving strain; therefore, the thirty-diameter rule should be applied to all auxiliary as well as to primary and secondary pulleys, for the reason that a small arc of contact affords no greater easement than if the ropes occupied half the circumference.

Shafts Slightly Out of Alinement

When shafts are only slightly out of alinement ropes will direct themselves without the aid of guide pulleys, but to what extent this angularity may be carried depends largely upon center distances and pulley diameters. For example, under what may be considered good conditions—say with centers not less than three times the average diameter of the pulleys—a deflection of 7 degrees might be ventured upon. Should the angle of deflection from the parallel prove too great to be treated in the above-mentioned manner, the drive may be split up into two or more spans by the introduction of intermediate shafts and the angle divided between them. An angle of 15 degrees was thus successfully negotiated in a drive represented by the sketch, Fig. 7. It should be stated that the grooves in all the pulleys were turned to an angle of 50 degrees, and rather more rope applied than would be considered under ordinary conditions.

Tilted Grooves

Tilted grooves similar to the series shown in Fig. 8 are sometimes brought into requisition for out-of-parallel driving, with the object of inducing the rope to catch on and slide down the side having the greatest inclination from the vertical, until it reaches the true driving position. There are, however, other equally potent considerations which appear to have been overlooked in the application of such grooves, viz., the one-sidedness of the pressure and the impossibility of even impact. Referring to Fig. 9, it will be observed that when the rope passes the center of the driving pulley—the smallest—the line of impact runs parallel with the track of the grooves at whatsoever angle the pulley may be fixed.

Wide-angled and well-polished grooves appear to best answer the requirements of this class of driving, while absolute smoothness throughout can scarcely be too strongly insisted upon, seeing that the ropes must graze the terminals in passing to their work.

Long keyways cut in both shafts are a decided advantage in the arrangement of awkward drives, as they permit the movement of pulleys to their most effective working position, which may only be discovered by practical tests.

Driving with Crossed Ropes

When it is necessary to transmit power to and from shafts revolving in opposite directions, the friction at the crossing points may be considerably lessened by running the ropes in pairs, with the tight of each traveling together, while the slack passes with slight pressure at the off side.

This arrangement also makes it possible to run a pair of ropes on double-grooved pulleys. If more than two ropes are employed, it is, of course, necessary to allow sufficient space between the pairs to permit the free passage of the adjoining trailing spans, which also travel in unison (see Fig. 10). Therefore, with four ropes a crossed drive will require six grooves, a six-rope drive ten grooves, and so on. A better method still is to fix separate two-grooved pulleys for each pair of ropes.

Half-crossed Rope Driving

Fig. 11 illustrates the application of ropes to half-cross driving, which may be either vertical or horizontal. In the latter position ropes are often used to convey power from the vertical spindles of water turbines to shafts running at right angles. The method of adjustment is practically the same as that adopted for belts, that is, as to the leading side following a direct line from pulley to pulley, while the working side is drawn away at an angle governed by the relation of shaft centers with pulley diameters.

Vertical Driving

Some years ago we were called in to advise upon a case where, in order to overcome the effect of gravitation, a perpendicular had been transformed into an oblique drive by the introduction of an auxiliary pulley having double the number of grooves. Finding this nothing but an absorber of power, it was discarded,

with the result that the slack of the rope maintained an even curve when running, after the manner displayed in Fig. 12. A similar drive in the north of Ireland was originally constructed upon the continuous system with a central tension pulley. This, giving endless trouble, was converted into a multiple-rope drive, and the power is now most effectually conveyed from the basement up to the fourth story of the mill. We generally advise perfectly vertical drives to be well roped, particularly if the bottom pulley happens to be the smallest, and to have moderately acute grooves, not exceeding 40 degrees.

Driving with Fast and Loose Rope Pulleys

Hitherto we have confined our attention to what may be designated main driving, either from the engine or from the line shafts. Now let us proceed a step further and discuss the equally important question of driving machinery when the motion is not constant. By an arrangement known as fast-and-loose rope pulleys, ropes have superseded belts in many of our cotton mills.

In a mill where this system of driving may be said to have met with its first great success, the power is entirely transmitted by ropes from a central shaft running the whole length of the room, thence both ways along a series of ring spinning frames (erected at right angles with the shaft) and over guides down to the encased driven pulleys near the floor. By this means a much longer horizontal than vertical span is secured for the ropes, which, owing to the weight between the sustaining points, are maintained at an easy driving tension.

At another mill, where the above-named conditions have not been observed, inasmuch as the vertical span is longer than the horizontal, it is necessary not only to use slightly thicker ropes, but also tightening arrangements on the guide-pulley fixings. When a slow start is required, a shallow V-shaped intermediate groove is turned on the fast sheave, in which the rope gains a revolution before passing to its work.

The effort required to push the rope in and out of gear is very slight indeed, and when running between smooth and rounded prongs which take the curve of the pulleys as per sections shown above the grooves, Fig. 13, the momentary friction need scarcely be considered a damaging factor in the life of the rope. Nor does the fact of the loose groove standing higher than the fast one militate in any way against the sensitiveness of the action.

The ropes used in the mill first mentioned are 13/16 inch in diameter only, and are doing the work of 3½-inch leather belts. Many of these ropes have already run for close upon five years. Nor is the use of fast-and-loose pulleys restricted to spinning frames. They are used most effectively in bleach works, in mechanics' shops, for milling machinery, mortar mills and other classes of machinery.

Grooves

Before dismissing the purely mechanical side of the question, a most important item still awaits our careful consideration, that is, the construction of grooves. The fact that when loads are constant the trailing span curves by its own weight down upon or away from the pulleys, according to the direction of rotation, and is ejected, so to speak, without any disturbance or apparent effort, also that a cotton rope may be pressed as tightly as possible around the entire circumference, and will yet fall away immediately the ends are liberated, pretty conclusively demonstrates the futility of seeking easement in curvatures to match in some measure the roundness of the rope itself.

Curved-sided grooves, similar to sketch, Fig. 14, having proved not only a hindrance to driving force, but also a stimulus to that destructive rolling action which is the very antithesis of good practice, should, therefore, always be discouraged.

Revolving Ropes

The above-mentioned convolutions do not, as a rule, take the circuit of the pulleys, but are usually conducted along the trailing span to the point of seizure where the periphery in actual contact at the moment is held and carried forward. Nor are they always constant, but are sometimes so erratic that ropes will fix themselves for a period and then roll over, to be compressed at another point, until their sections become irregular polygons.

When the rolling action is continuous, the whole surface of the ropes so acted upon becomes perfectly round and bright, as distinguished from the rougher appearance of their fellows. This deleterious action is not always avoidable, even in angular grooves, unless they are moderately acute. Hence one of the reasons for recommending grooves of not more than 40 degrees. Whatever the cause, it is computed that the life of a rope is reduced by at least one-third when it revolves.

Curves being disallowed there remains only the angular groove. Undoubtedly every rope has its most suitable groove angle, but as the providing of a range of templets to agree with every advance in size would, perhaps, prove more inconvenient than advantageous, two leading angles have been fixed upon for all driving ropes, viz., 40 degrees for those

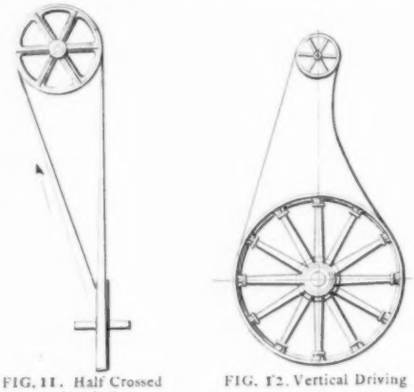


FIG. 11. Half Crossed Vertical

FIG. 12. Vertical Driving

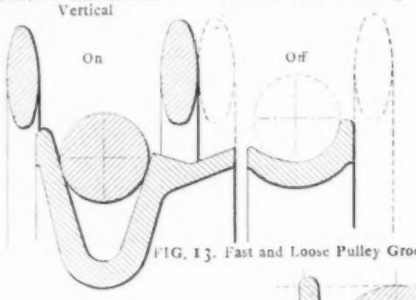


FIG. 13. Fast and Loose Pulley Grooves

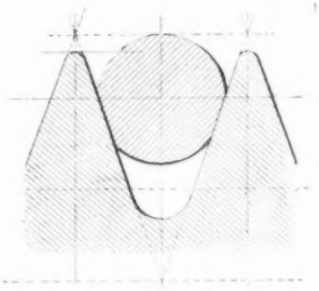


FIG. 16. Flangeless Groove

FIG. 14. Curved Sided Groove

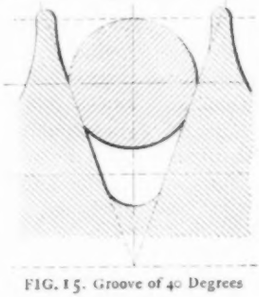


FIG. 15. Groove of 40 Degrees

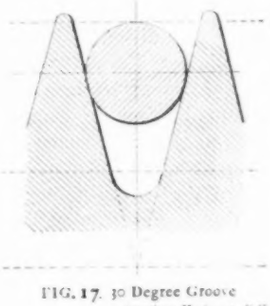


FIG. 17. 30 Degree Groove

American Machinist, N.Y.

DETAILS OF ROPE DRIVES

above 1¼ inches in diameter, and 30 degrees below that size; excepting, however, the small bands used for driving cotton machinery, say ½ inch in diameter and even less, when angles as sharp as 15 degrees are brought into requisition. In setting out a groove it should always be borne in mind that a rope is to all intents and purposes an elastic wedge, and reaches its highest driving capabilities when it is compressed to the shape of the groove itself. This cuniform ought, therefore, always to be anticipated, for if the sides of the groove are merely shown as tangents to the circle representing a given diameter of rope, there is always the danger of making the groove too shallow, so that when compression takes place the rope is liable to find its way to the bottom, or, what is almost as detrimental, work upon the semi-circle with which grooves generally terminate, when grip is considerably weakened and slipping supervenes, the true indication of which is heated pulley rims.

Finding that superposed flanges do not contribute in any way to better transmission, but rather prevent the rope falling direct into its working position if the driving is at all unsteady, besides crippling any extension in the direction of a larger diameter, many engineers are now adopting flangeless grooves, which are set out in precisely the same manner, only that the angles are extended and simply rounded off at the terminals, as shown in the section, Fig. 16.

The pitch is gained by measuring from center to center of the mid-feathers along the horizontal line passing through the circle, and this multiplied by the number of ropes, adding the thickness of two apices to represent the extra metal required for outside flanges, will give the total width of the pulley.

Grooves having no power to transmit, but which are used merely to bear up or conduct ropes out of the straight driving path, should be so constructed that they (the ropes) may rest easily at the bottom, while the mid-feathers open outward. The pitch of these grooves should, of course, correspond with the transmitters to which they are tributary.

When templets of existing grooves are required, the quickest and surest way is to take plaster casts, the grooves being previously well greased. These give more readily measured definitions than may be secured by attempting to cut pieces of timber, tin, or other available material to the desired shape, whch serve rather to perplex than to guide the judgment in the selection of suitable ropes, particularly when the pairs do not agree, although respectively intended to represent the grooves of driving and driven pulleys.

Driving Ropes

Beyond incidental acknowledgments of its existence, the medium of transmission has hitherto been scarcely mentioned, not because its importance is inferior to any other factor which plays a part in the general economy of the system, but from a desire to emphasize at this juncture that much-neglected phase of the question which deals with the composition and construction of driving ropes.

Many and various are the materials which have been pressed into the service of the ropemaker—an almost infinite variety of fibers, through the whole range of hemps and flaxes, from the coarse-grained manila to the silk-like ramie, and finally cotton. Ropes have also been made from paper strips, but one experiment was more than enough to prove their inaptitude for the purpose, as the rope under trial collapsed after less than an hour's running.

Manila

Owing, it may be conjectured, to the fact that rope driving was cradled in what may be styled the home of the manila trade, that material gained for a time precedence above all others, and, if merely judged on the lines of resistance to tensile strains, would still hold the field. The fibers are, however, of so harsh and wiry a nature that they cannot be compressed into a solid mass by the successive twisting operations to which they are subjected, but, instead of forming a perfect impact, the strands merely rest upon each other, thus constructing what may be termed a spiral tube. The strands, therefore, scrub one upon another with every bend of the rope until the center is reduced to a fine powder.

The permanent set is thus quickly reached, while gripping power is so limited that any reduction in the pulleys from 45 diameters must be reciprocated with a corresponding increase in the amount of rope. An advocate of continuous driving recommends 60-rope diameters for manila. When the system was first introduced into the Lancashire district, experiments were soon tried in the direction of applying cotton to the manufacture of driving ropes, seeing that no other material was found capable of transmitting power to the various motions of a cotton-spinning mule, the particular ramifications of which demand a rope possessing great resilience as well as endurance.

Cotton versus Manila

In making our selection between the two materials it will not be wise to lay too much stress upon initial cost; for, although cotton is much dearer than manila, its superior resilience, grip and groove impact add so greatly to the driving force that at least one-third more power may be transmitted. Further, its prolonged life, which may be reckoned at not less than three to one respectively, reduces apparently excessive first charges to a very insignificant item. The foregoing statement considerably underestimates relative durabilities, if we take by way of comparison a case where best yacht manila ropes (than which there could be none better of the class) were so heavily worked upon a traveling crane that their average life did not exceed six months, whereas a cotton rope was only recently replaced by another of the same make, after running four years and three months under precisely the same conditions.

The mention of a few among a large number of replacements in the north of Ireland will doubtless suffice to exemplify the higher capabilities of cotton over manila. In the case of a large flax mill where, owing to some miscalculations, manila proved totally inadequate to transmit the required power, the same number and diameter of cotton ropes are now comfortably driving the added load of a dynamo for electric lighting.

At another well known flax mill manila ropes were originally employed to drive what is known as a 108-inch mangle; but, after a brief existence, during which many fruitless efforts were made to prevent slipping by frequent tightening and other methods, the difficulties were ended by the introduction of cotton ropes. Still another example giving a more definite comparison. At one of the leading mills of the district, eight manila ropes 2 inches in diameter upon one drive and ten 1¼ inches in diameter upon another were replaced by six and eight cotton ropes respectively, and the driving is pronounced to be much more satisfactory in every respect.

As to the life of cotton driving ropes, much, of course, depends upon their size and the conditions under which they have to work. All things being equal, durability may be gaged by sectional area. The most economical diameters range from 1½ inches to 1¾ inches, more of the latter being used than any other size for large powers.

A remarkable case of longevity may here be quoted, where 24 cotton ropes 1¼ inches in diameter are employed to transmit 820 horsepower, at a velocity of 4396 feet, direct from the engine flywheel, 28 feet in diameter, to the various rooms of a Lancashire cotton mill. These were fixed in September of 1878, and all the ropes driving the card room have been running from then until now, a period of thirty years, without any attention more than tightening two of them which were accidentally saturated with water. Another set fixed in April, 1885, has been working an average of 20 hours per day ever since, and appear to be little the worse for their twenty-three years' service.

The lives of other cotton driving ropes similarly circumstanced have extended over periods little short of this, while others again, fixed from eleven to fifteen years ago, though working without cessation, week ends excepted, are still doing good service. A good example is to be

found at a large paper works near Glasgow, where cotton ropes have been working night and day for nearly fifteen years. Such cases of longevity lead to the conclusion that fatigue of material due to constant activity does not readily manifest itself in well made cotton driving ropes. Under the head of longevity may be mentioned the cotton fan-driving ropes at the Britannic colliery, Gilfach, which have already been running without renewal for fifteen years, practically night and day. A service of ropes has also been employed for fourteen years under similar conditions at the Powell Duffryn Company's New Tredegar pit.

Construction of Ropes

Simple as it may appear, much more depends upon the construction of a driving rope than is generally supposed. Fibrous ropes, it will be observed, are, as a rule, held together by a series of twisting operations from the fiber to the yarns, and then the strands, which are locked together by a reversal of the same agency.

Ropes of three, four, and even seven strands are sometimes employed; there are also lapped ropes so-called because of the serving of thick cord on the outside of a three-strand rope after the interstices have been filled in with soft yarn. This outer lapping forms a close spiral upon the larger ones of the rope proper, and not only prevents their free action, but also, what is most undesirable, stiffens the contour. Then there is the square manila rope of German manufacture, with strands interwoven instead of twisted together; but this style, besides having those disabilities common to the material, is also opposed to that spiral action which, as we have endeavored to show, is inseparable from true resilience.

Four-strand Ropes

Seeing, however, that the contest on method of construction lies more particularly with four- and three-strand ropes, it will be advisable to devote a little more attention to these than the other makes. Taking them in the order mentioned, it may be said that the most striking feature in a four-strand rope is the support given by the insertion of a central core, without which it would be impossible to construct an even periphery. If, then, this core is an indispensable adjunct, its collapse must mean the dislocation of the whole structure; and as its usual dimension is only about one-fourth part of the entire bulk, it may be reasonably assumed that the superior force exerted by the alternate contraction and extension of the spiral as the rope passes over the pulleys must tend toward the breaking up of this core, the period of endurance being limited by its elasticity and the tension at which it is laid. That is what actually takes place. This central core also interferes most effectually with the free working of the spiral represented by the body of the rope, upon which too much stress can scarcely be laid; hence the frequent reference.

Nor is this the only defect. Every subdivision of the total bulk elongates this spiral, bringing it nearer to the straight line and thereby curtailing its elasticity. This probably will be best understood by referring to a four- and three-strand rope in parallel. Thus the three strands gradually gain upon the four in the proportion of 1 in 5, or in other words, six turns occupy the space of five, respectively. The spirals of a seven-strand rope are still nearer the straight line, being almost double the length of a three-strand rope. By tracing a single strand round its full turn another important difference is observed, which affects the bending capacity of the rope. Thus in a three-strand only two strands come between successive turns, while there are three between the turns of a four, and six between the turns of a seven-strand rope. Groove impact is also much impaired by the use of four-strand ropes, which, instead of fixing, rather encourage the rolling action so detrimental to durability. So much are these disabilities felt that larger pulleys, the luxury of three-strand, become the necessity of four-strand ropes.

Three-strand Ropes

A brief study of the three-strand rope section discloses, among other advantages, the effect of triangulated strains upon pliable material under the equal pressure exerted by the twisting operation already mentioned. Here we have a trinity of elastic spiral wedges so impacted that no space remains unoccupied, and so supple that they will bend to and fro without disturbing their mutual relationship. This venerable principle, as applied to rope making, holds as good today as ever, and, so far, admits of no improvement save in details, which shall be presently discussed.

A three-strand rope, which has had an average running of 20 hours per working day for 15 years, has been removed from

Rope Diameters	1"	1¼"	1½"	1¾"	2"	2¼"	2½"	2¾"	3"
Minimum Diameter of Smallest Pulley	2' 6"	2' 10"	3' 2"	3' 5"	3' 9"	4' 1"	4' 5"	4' 9"	5'
Velocity in Ft. per Min.									
1000	13.3	14.1	15.1	16.1	17.4	18.6	20	21.5	23
1100	13.6	14.5	15.6	16.7	18.1	19.5	21	22.6	24.3
1200	13.9	14.9	16.1	17.3	18.9	20.3	22	23.8	25.6
1300	14.2	15.3	16.6	18	19.7	21.2	23	24.9	26.9
1400	14.6	15.7	17.1	18.6	20.4	22	24	26	28.3
1500	14.9	16.1	17.6	19.2	21.1	22.9	25	27.2	29.6
1600	15.2	16.6	18.1	19.8	21.9	23.8	26	28.4	30.9
1700	15.5	17	18.6	20.4	22.6	24.6	27	29.5	32.2
1800	15.8	17.4	19.1	21	23.4	25.5	28	30.7	33.5
1900	16.2	17.8	19.6	21.6	24.1	26.3	29	31.8	34.8
2000	16.5	18.2	20.1	22.2	24.9	27.2	30	32.9	36.1
2100	16.8	18.6	20.6	22.8	25.6	28.1	31	34.1	37.4
2200	17.1	19	21.1	23.4	26.3	28.9	32	35.3	38.7
2300	17.5	19.5	21.6	24	27.1	29.8	33	36.4	40
2400	17.8	19.9	22.1	24.7	27.8	30.7	34	37.6	41.3
2500	18.1	20.3	22.6	25.3	28.5	31.5	35	38.7	42.6
2600	18.4	20.7	23.1	25.9	29.2	32.4	36	39.9	43.9
2700	18.7	21.1	23.6	26.5	30	33.3	37	41	45.2
2800	19.1	21.5	24.1	27.1	30.8	34.1	38	42.1	46.5
2900	19.4	21.9	24.6	27.7	31.5	35	39	43.3	47.8
3000	19.7	22.3	25.1	28.3	32.3	35.8	40	44.4	49.1
3100	20	22.7	25.6	28.9	33	36.7	41	45.5	50.3
3200	20.4	23.2	26.2	29.6	33.8	37.6	42	46.6	51.6
3300	20.7	23.6	26.7	30.2	34.6	38.4	43	47.8	52.8
3400	21	24	27.2	30.8	35.3	39.3	44	48.9	54.1
3500	21.3	24.4	27.7	31.4	36	40.2	45	50	55.3
3600	21.7	24.8	28.2	32	36.8	41	46	51.1	56.5
3700	22	25.2	28.7	32.6	37.5	41.9	47	52.2	57.8
3800	22.3	25.6	29.2	33.2	38.2	42.7	48	53.3	59
3900	22.6	26	29.7	33.8	39	43.6	49	54.4	60.2
4000	23	26.4	30.2	34.5	39.7	44.5	50	55.5	61.4

Rope Diameters	1"	1¼"	1½"	1¾"	2"	2¼"	2½"	2¾"	3"
Minimum Diameter of Smallest Pulley	2' 6"	2' 10"	3' 2"	3' 5"	3' 9"	4' 1"	4' 5"	4' 9"	5"
Velocity in Ft. per Min.									
4100	13.3	16.9	20.7	25.1	30.4	35.3	41	47.1	53.5
4200	13.6	17.3	21.2	25.7	31.2	36.2	42	48.3	54.8
4300	13.9	17.7	21.7	26.3	31.9	37	43	49.4	56.1
4400	14.3	18.1	22.2	26.9	32.7	37.9	44	50.6	57.4
4500	14.6	18.5	22.7	27.5	33.4	38.8	45	51.7	58.7
4600	14.9	18.9	23.2	28.1	34.2	39.6	46	52.9	60
4700	15.2	19.3	23.7	28.7	34.9	40.5	47	54	61.3
4800	15.6	19.8	24.2	29.4	35.7	41.4	48	55.2	62.7
4900	15.9	20.2	24.7	30	36.4	42.2	49	56.3	64
5000	16.2	20.6	25.3	30.6	37.1	43.1	50	57.5	65.3
5100	16.5	21	25.8	31.2	37.9	43.9	51	58.6	66.6
5200	16.9	21.4	26.3	31.8	38.6	44.8	52	59.8	67.9
5300	17.2	21.8	26.8	32.4	39.4	45.7	53	60.9	69.2
5400	17.5	22.2	27.3	33	40.1	46.5	54	62.1	70.5
5500	17.8	22.6	27.8	33.6	40.9	47.4	55	63.2	71.8
5600	18.2	23.1	28.3	34.3	41.6	48.3	56	64.4	73.1
5700	18.5	23.5	28.8	34.9	42.3	49.1	57	65.5	74.4
5800	18.8	23.9	29.3	35.5	43.1	50	58	66.7	75.7
5900	19.1	24.3	29.8	36.1	43.8	50.8	59	67.8	77
6000	19.5	24.7	30.3	36.7	44.6	51.7	60	69	78.3
6100	19.8	25.1	30.8	37.3	45.3	52.6	61	70.1	79.6
6200	20.1	25.5	31.3	37.9	46.1	53.4	62	71.3	80.9
6300	20.4	25.9	31.8	38.5	46.8	54.3	63	72.4	82.2
6400	20.8	26.4	32.4	39.2	47.6	55.2	64	73.6	83.6
6500	21.1	26.8	32.9	39.8	48.3	56	65	74.7	84.9
6600	21.4	27.2	33.4	40.4	49	56.9	66	75.9	86.2
6700	21.7	27.6	33.9	41	49.8	57.7	67	77	87.5
6800	22.1	28	34.4	41.6	50.5	58.5	68	78.2	88.8
6900	22.4	28.4	34.9	42.2	51.3	59.4	69	79.3	90.1
7000	22.7	28.8	35.4	42.8	52	60.3	70	80.5	91.4

TABLE OF HORSEPOWERS WHICH GOOD THREE-STRAND COTTON DRIVING-ROPES WILL TRANSMIT (ALLOWING A GOOD MARGIN OF SAFETY), RUNNING UPON PULLEYS NOT LESS THAN THIRTY TIMES THEIR RESPECTIVE DIAMETERS.

a mill, owing to structural alterations. The exterior is abraded, but abrasion which may be expected in a fixed rope after the first year's work need not alarm the user, as it is merely the ruffling of the fine outer fibers, which fill up the interstices of the strands, and offer a cushion against the sides of the grooves.

Two examples will suffice to demonstrate the superior driving force of three-strand over four-strand ropes. A firm of oil-cake manufacturers who had their four-strand ropes replaced, after a run of less than two years, with the same number and size of three-strand, volunteered the information that while they dared not impose a load greater than 110 horsepower upon the four-strand, with the three-strand ropes, which have now been running over seven years, they could impose a load of 170 horsepower with impunity. At another replacement, where pulleys were a little below the standard diameter and centers rather short, four three-strand ropes were found to transmit the power with greater ease than six of four strands.

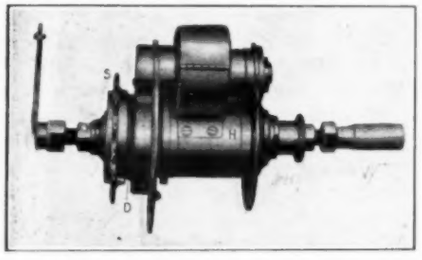


FIG. 1. EXTERIOR OF VARIABLE-SPEED GEAR

Allowing the claims put forward in favor of three-strand ropes without further advocacy of the general principle involved, it may be logically contended that if such a rope possesses constant equality throughout, if the yarns are equal in counts, number, strength and tension, each one following its appointed track without deviation, and are all of the best quality procurable, then have we arrived at a point bordering on perfection in the making of driving ropes. What has become favorably known as the patent inter-stranded cotton driving rope is the nearest possible approach to these requirements yet devised. Each of the three strands is made up of a succession of sheaths or layers of yarn, which may be peeled off one by one until the last section is reached. The constantly increasing bulk due to the laying on of these concentric rings has the effect of lengthening the yarns of each succeeding layer in corresponding gradations, so that one taken from the outside of a strand in a rope 1½ inches in diameter is nearly 18 per cent. longer than that taken from the center, the difference, of course, being greater in a thicker rope. This inter-stranding process also insures a more compact mass of fibers than may be compressed into the same area by any other process, thus securing a higher breaking strain, greater driving force, and longer life, besides immunity from undue stretching. The result of even lay and tension is well manifested in the open strand of one of these ropes, particularly if compared with the inside of a strand upon which no such care in construction has been bestowed. The result of this malconstruction is to be seen in the crinkling up of the inner yarns at the expense of straining the outer ones, which must soon yield under driving stress and release by degrees the less taut yarns below the surface, themselves providing ample scope for extension, so that frequent tightening becomes a disagreeable necessity.

Lubrication of Driving Ropes

The chief function of lubricating material as supplied to cotton driving ropes is that of providing a smooth filmy coating to assist the lay and prevent friction between the twisted surfaces in contact, where the strands impact with each other. Relubrication, therefore, is seldom necessary, unless the ropes are working in an unusually dry atmosphere, and even then should be only sparingly served at long intervals.

Greasy compounds likely to penetrate the fibers should be scrupulously avoided, as tending to induce slipping. When ropes have been so treated, a liberal application of whiting is usually recommended, which absorbs the grease and falls away in flakes. The most serviceable lubricant is compounded from saponified tallow, wax and plumbago, which sets hard like domestic soap.

The output of vanadium in the United States, according to statistics of "The Mineral Industry," made a substantial increase last year. In 1908 the production was 64,800 pounds ($162,000), while in 1907 it amounted to 41,000 pounds ($102,500).

A Variable Speed Gear

By Arthur W. Jones

The gear here described, although designed merely as a fitment for the bicycle, bristles with points of interest and its construction and arrangement are totally unlike anything previously devised for the purpose. Attention may particularly be called to the low gear train which is probably unique, to the special gear-tooth form, and to the embodied clutches which, although quite positive in action, consist of a single moving part only; also to the fact that the necessary gears, the planets of which are carried in bearings attached to the hub shell, are, as will be seen from Figs. 1 and 2, not entirely concealed in the hub, but partly project through it at an opening between the spoke flanges, where they are protected from injury by a removable dust-proof cap—omitted from Fig. 2 for the sake of clearness. Its inventor, Mr. Pedersen, was the originator of the cantilever bicycle, illustrated in the American Machinist on page 582, Volume 21.

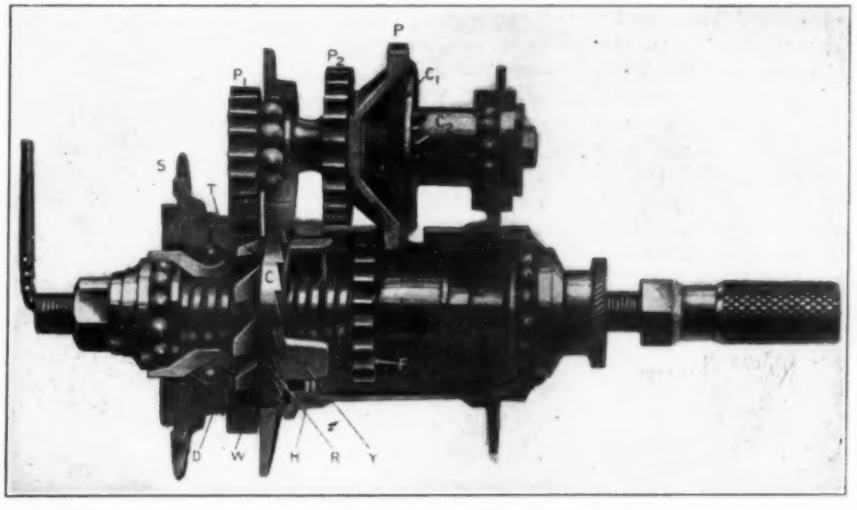


FIG. 2. CROSS-SECTION OF VARIABLE-SPEED GEAR

Weighing only some 12 ounces more than a plain hub, its construction yet allows of the use of gears appreciably larger and stronger than usual, and as the load on the first pair is always taken on one side of the teeth only, this feature has been taken advantage of to obtain still further strength. Referring to Fig. 3, it will be noticed that the driving faces of the teeth are of normal outline, but that the opposite faces are cut away at the tips and strengthened at the roots, giving a tooth form distantly resembling a buttress thread. All revolving parts are mounted on ball bearings, and no balls of less than 3/16 inch diameter are used. An automatic free wheel for each gear is embodied in the hub itself, and each gear is 50 per cent. higher than the preceding one giving, for example, a normal "solid" gear

of 70 for general use, a low one of about 47 for hill climbing, and a high gear of 105 for riding before the wind, or down slight inclines where the gradient is insufficient for free-wheeling. The gears can be changed at any time by the movement of a small lever (of the first order) attached either to the handle bar or to the top frame tube. The lever operates by means of a flexible steel cord attached to the small chain which can be seen protruding from the hollow axle end, and this in turn is directly connected to the nonrotating sun wheel F, Fig. 2.

Normal Drive

Fig. 2 serves to illustrate the normal or "solid" drive with the gears out of action. The floating crown wheel C has cut upon its inner edge fine ratchet teeth R corresponding to similar teeth cut in the hub shell H, and upon its outer edges coarse teeth T, of special form which are always in engagement with like teeth cut upon the driving ring D, which carries the spur wheel W and has screwed upon it the chain sprocket S. A forward rotation of the sprocket forces the floating crown wheel toward the center of the hub and causes the ratchet teeth to engage with those in the hub shell, driving it forward at an equal speed. On ceasing to pedal the hub overruns the ratchet teeth on the crown wheel which then recedes out of engagement and so remains until pedaling is resumed.

High-gear Drive

To put the high gear into action the controlling lever is pushed forward. This relieves the tension on the wire cord and allows the spring, which can be seen coiled around the axle, to push the fixed sun pinion F into engagement with the planet P. The planets P and P_2 comprise a single separate part which is sleeved upon the long spindle of planet P_1, and upon which it is free to rotate until put into operation by the clutch plate C_1, whose driving member C_2 is positively attached to planet P_1. The gears now in engagement are shown diagrammatically in Fig. 4, and the directions of rotation of the different parts are also marked. It will be noted that the planet P_1 engaging with the driving gear W rotates about its axis in the same relative direction, and as the hub also rotates in this direction it follows that it must overrun the driving sprocket. Actually for one rotation of the sprocket the hub will revolve:

$$\frac{W \times P}{(W \times P) - (P_1 \times F)} \text{ times.}$$

Or with $W = 33$ teeth, $P = 29$ teeth, $P_1 = 16$ teeth, and $F = 20$ teeth, we get

$$\frac{33 \times 29}{(33 \times 29) - (16 \times 20)} = \frac{957}{637} =$$

1.5 revolutions of hub for one of sprocket.

Were the two planet pinions in use rigidly locked together "free-wheeling" (or the ability to cease pedaling) would obviously be impossible as the chain sprocket would be forced to revolve as long as the hub continued to do so. To obviate this the second clutch, shown at C_1 and C_2, Fig. 2, and similar in character to the crown wheel already described, is interposed between the planets, and when

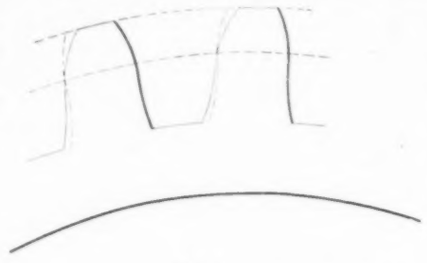


FIG. 3 *American Machinist, N.Y.*

TEETH OF MAIN GEAR OF VARIABLE-SPEED GEAR

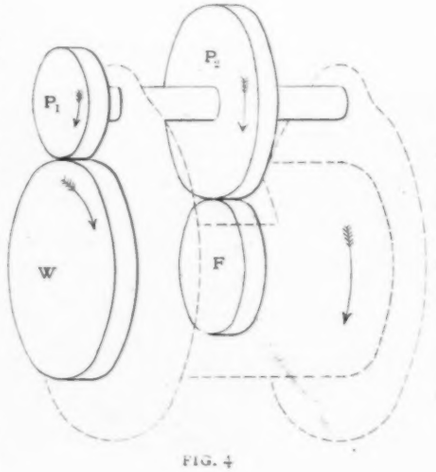


FIG. 4

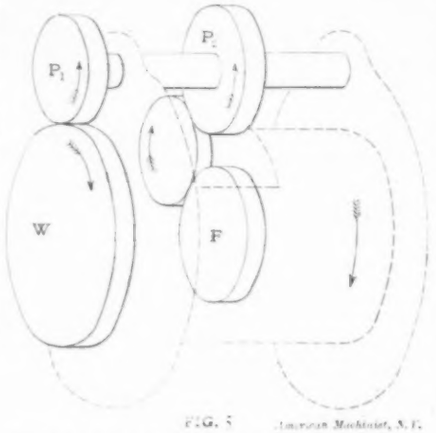


FIG. 5 *American Machinist, N.Y.*

DIAGRAMS OF GEARS FOR HIGH- AND LOW-GEARED RATIOS

pedaling is stopped this disengages and allows each planet to revolve independently around its respective mating wheel.

Low-gear Drive

The low gear, shown in diagram in Fig. 5, is obtained by pulling the controller lever toward the rider. This pulls the nonrotating wheel F into engagement with an idler planet wheel, see Fig. 5, which is always in mesh with the smaller planet P_2—the gears W and P_1 also are always in mesh. Looking at Fig. 5 it will be seen that the insertion of the idler in the planet train now causes P_1 to revolve on its own axis in an opposite direction to that of its driving gear W and consideration will show that although the hub still revolves in the same direction as before, it must necessarily be at a lower speed than that of the driving sprocket, for one revolution of which the hub will rotate:

$$\frac{W \times P_2}{(W \times P_2) + (P_1 \times F)} \text{ times.}$$

Or with $W = 33$ teeth, $P_2 = 19$ teeth, $P_1 = 16$ teeth, and $F = 20$ teeth, we get

$$\frac{33 \times 19}{(33 \times 19) + (16 \times 20)} = \frac{627}{947} =$$

0.66 revolutions of hub for one of sprocket.

As the hub now rotates at a *slower* speed than the driving sprocket it may be asked why the crown ratchet wheel C does not come into operation to prevent this. The explanation is that when pulling over the sun pinion F its side face has come into contact with the projections on the disengaging ring Y mounted in the hub shell, and this in turn has pressed back the ratchet wheel until its teeth are out of engagement, in which position it is held so long as this gear is in use. When free-wheeling the clutch C_1 on the planet-pinion shaft disengages in the same way as was explained for the high gear.

As may be imagined, the most difficult machining operation is probably the cutting of the clutch teeth in the driving ring D, as these are almost completely overhung by the gear wheel W and with, moreover, a clearance of only 1/8 inch between them. The special automatic machine designed for this work has a forming tool mounted at the end of a link motion, and this cuts with a sort of curved movement. A cam feed is arranged so that the first cuts taken are heavy ones and succeeding cuts lighter, resulting in a smooth finish to the teeth. Somewhat similar machines are used for cutting the gear wheels, and it is claimed that the light finishing cuts leave a surface superior to that left by a milling cutter inasmuch as there is no tendency to bur over the metal at the leaving edge. All wearing parts are carefully case-hardened, samples being tested from each batch, and the result is that hubs have run up to 30,000 miles without showing appreciable signs of wear, or to put it more forcibly, assuming that the gears are in action for only 30 per cent. of the time, this is equivalent to about 650,000 revolutions of the hub driven through the gearing. The gear is manufactured throughout by the Dursley-Pedersen Cycle Company (proprietors, R. A. Lister & Coy. Ltd.), Dursley, England.

Some Interesting Types of Drill Jigs

Indexing Jigs, Jigs with Quick Acting Clamps and Other Handy Devices Are Used for Drilling and Reaming Holes in Accurate Machine Parts

EDITORIAL CORRESPONDENCE

We have published in these columns in the past a number of articles dealing with the tool-room methods pursued at the works of the Lanston Monotype Machine Company, Philadelphia, Penn., and we now present a number of illustrations showing various types of drilling jigs used by this company in the production of certain parts of its casting machine.

The halftone, Fig. 1, illustrates a pair of drilling and reaming jigs by means of which 225 holes are put through a sheet-steel plate known as the matrix case cover. The blank plate is shown at *A* and a plate already drilled will be seen at *B* on the jig at the left. The matrix case with the cover attached is shown in the background at *C* while at *D* is the clamp plate by means of which the work is secured to the jig during the drilling and reaming operations. The matrix case carries 225 matrices for the casting of as many characters and each matrix has in its blank end a taper hole for the reception of the index pin by means of which the case is correctly located over the mold for the casting of the corresponding type. The matrix-case cover is 3/64 inch thick and the holes have to be accurately located as there is little clearance between them and the taper pin which passes through into the matrix itself in indexing the case for the casting of the different characters, and a slight error in the location of any one of the 225 holes would therefore cause interference with this indexing pin and result in the incorrect positioning of the matrix case in its rapid adjustment over the mold during the casting operations.

The blank cover ready for drilling is placed on the upper slide of the jig, the clamp plate *D* dropped in place over four small studs and then drawn down tight by the four conical slotted nuts *E* on these studs, which enter the counter-sunk holes in the clamp plate. The upper slide *F* to which the work is attached is indexed under the drill bushing by a wedge-shaped spring-operated locking pin which enters between the teeth of a rack *G*, several teeth of which are exposed in the illustration. As each hole is drilled the locking pin *H* is withdrawn and the work-carrying slide *F* moved along one tooth when the locking pin again locates it in position for the next hole. The upper slide *F* with the work, as will be seen, is mounted upon a second slide *I*, adapted to be moved at right angles with the upper one, and having also an indexing rack and a spring locking pin *J*. After one row of holes is completed the lower or cross slide *I* is indexed one tooth and the second row of holes drilled, this process being repeated until all the holes are finished. The slides are easily manipulated and under a sensitive drill the work is handled conveniently and rapidly. The two jigs shown are duplicates so that drilling may be accomplished with one and reaming with the other, although, of course, by changing the bushings either jig may be used for both drilling and reaming operations.

Jigs with Novel Clamping Devices

Several jigs will be seen in Fig. 2 in which are employed some ingenious devices for clamping the work quickly and securely in position. Referring to the illustration of jig *A* which is shown open to reveal the character of the work and clamping mechanism, it will be seen that the piece *B* to be drilled is located against two side stops and one stop at the left-hand end. The work, which is a narrow strip of steel several inches in length, when dropped into place in the jig is moved toward the end stop by an oscillating jaw *C* carried by a sliding plate *D*, the latter being operated by an eccentric pin which engages in a slot under the plate and tends to move it forward when rotated by means of the nurled spindle *E* which has on its inner end a worm thread engaging with fine teeth cut on the peri-

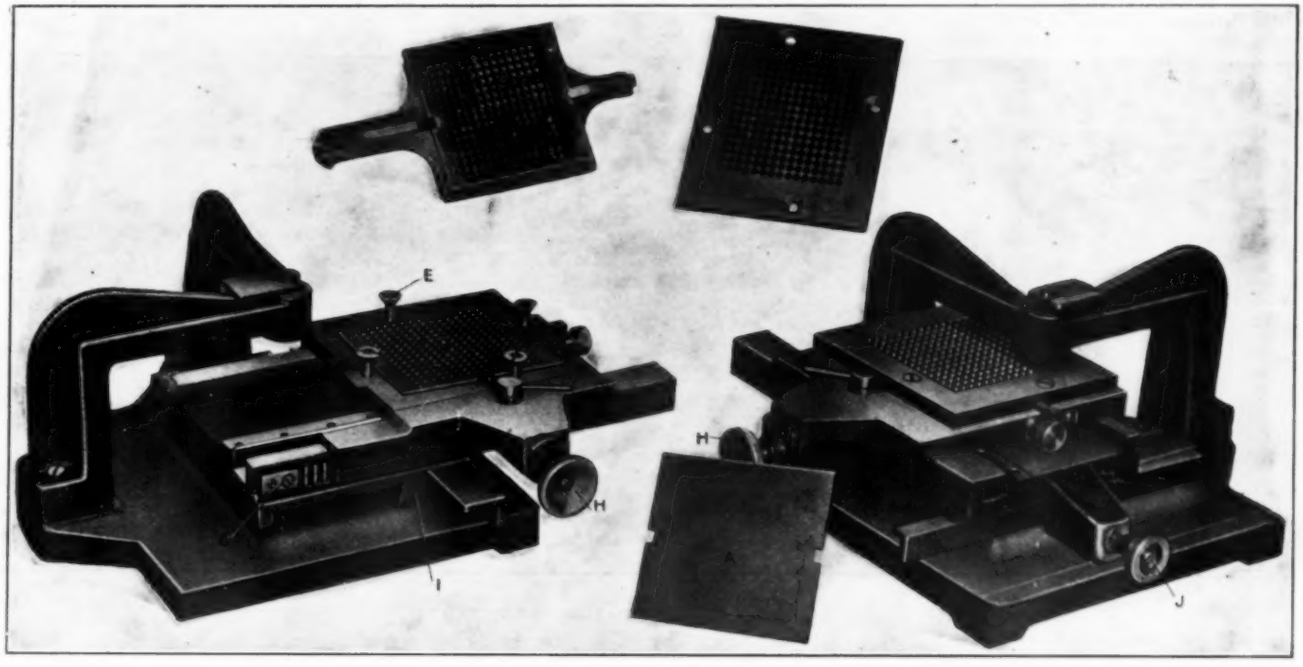


FIG. 1. INDEXING JIGS FOR DRILLING 225 HOLES IN A STEEL PLATE

phery of the eccentric pin under slide *D*. When *D* moves forward against the work the tendency of the latter as it is forced against the left-hand stop pin is to rotate jaw *C* to the right and cause the lower tooth of the jaw to force the work up against the stop pins at the side, any further pressure due to the forward movement of the slide *D* thus tending to press the work harder against both the end stop and side stops referred to. The left-hand end of the work is held firmly against its side stop by the swinging clamp *F* which is also operated by a small eccentric pin turned by a lever at the side which is not seen in the illustration.

This jig is used for both drilling and reaming, the drill bushes being carried in the jig leaf and the reamer bushes in the body. As will be noticed, the drill bushes are counterbored a slight distance from the bottom end thus providing sufficient clearance so that when the jig is turned over for the reaming operation the end of the reamer can enter the drill bushes for a short distance. The latch *G* by which the jig is closed is carried on a pin *H*, whose ends take an eccentric bearing in the jig body. When the jig is closed and pin *H* is turned to throw the latch *G* in operative position the action of the eccentric referred to is first to bring the hooked end of the latch against the pin in the jig leaf and then further rotation of the pin *H* in its eccentric bearings draws the latch down hard, closing the jig tight. When the latch pin *H* is turned in the opposite direction to open the jig the eccentric pin first lifts the latch and then allows it to move outward and release the jig cover. Thus only one movement of the pin carrying the latch is necessary to lock the jig and a single movement in the opposite direction to release it. The jig at *I* has practically the same construction as jig *A* and is shown closed with the latch drawn tight against the pin in the leaf.

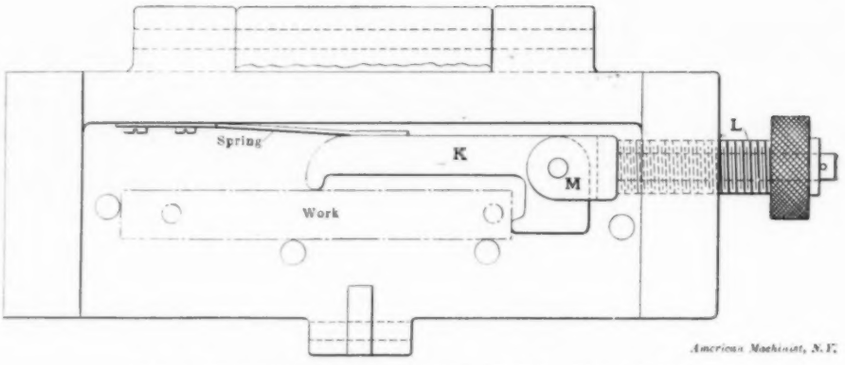


FIG. 3. CONSTRUCTION OF JIG WITH DOUBLE ACTING CLAMP

Another jig with an interesting clamping device for the work will be noticed at *J* in this engraving, while details of the clamp are shown in Fig. 3. As will be seen by referring to the drawing the work is forced up against the three stop pins, two at the side and one at the end, by a thin rocker arm *K* which is moved by the threaded sleeve *L* through which the shank of the fork *M* passes freely. It is obvious that when the screw *L* is turned to move *K* forward and the short end of the rocker arm comes in contact with the work, the latter as soon as it is forced against the end stop causes the long arm of *K*, which is already held by the flat spring in contact with the side of the work, to press the work against the two

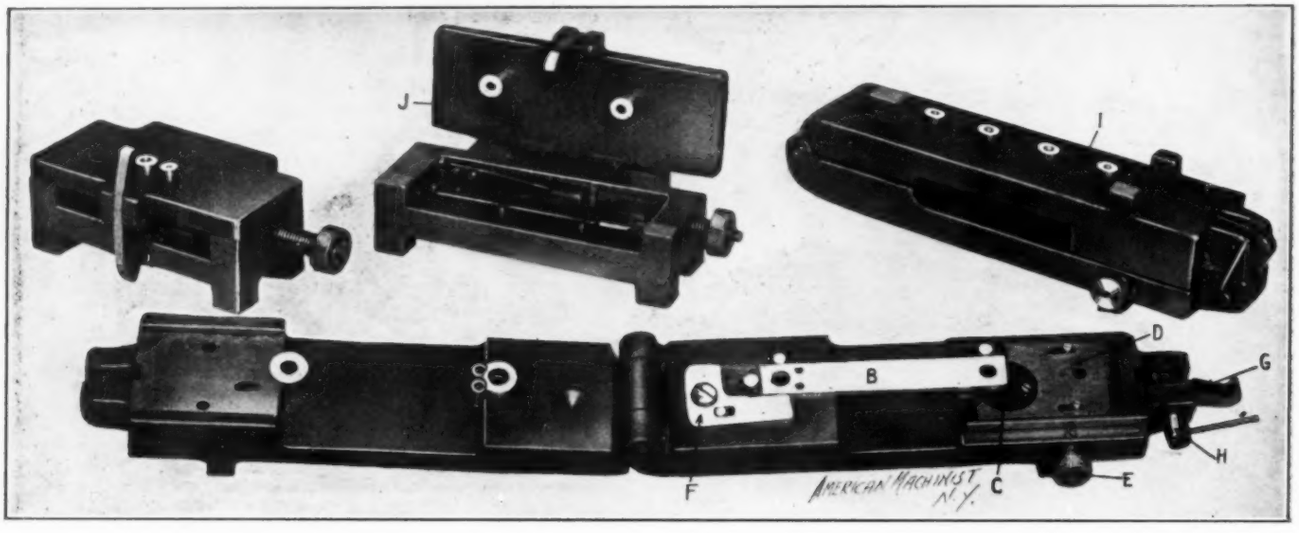


FIG. 2. JIGS WITH QUICK ACTING WORK CLAMPS

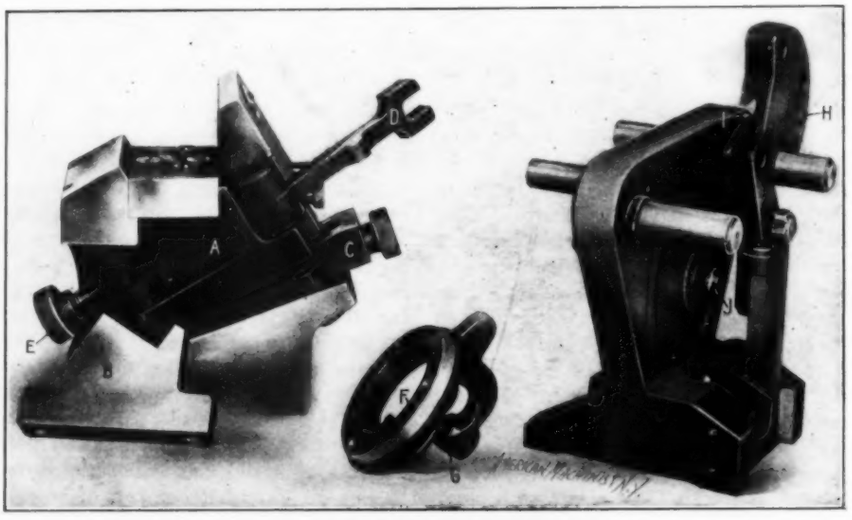


FIG. 4. TWO HANDY JIGS

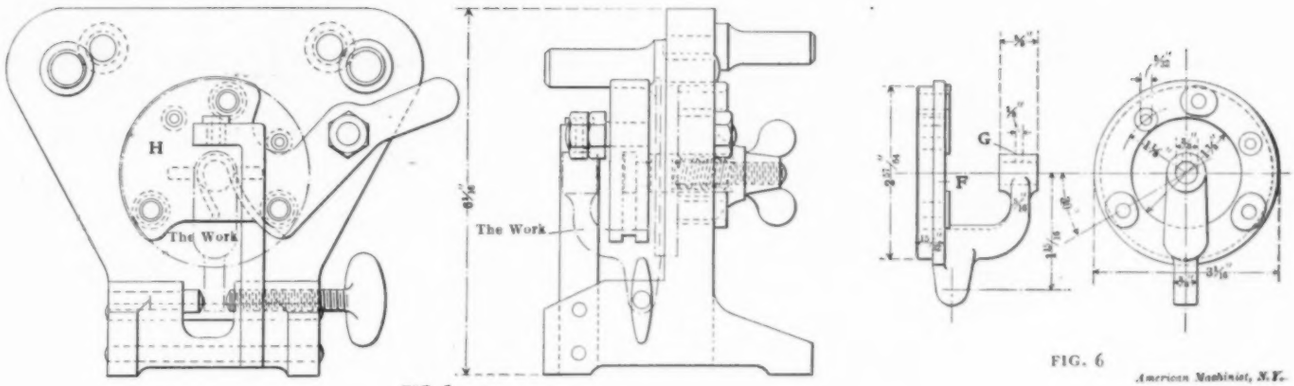


FIG. 5 FIG. 6

CONSTRUCTION OF JIG WITH HANDY CLAMP

side stops. The jig at the left in Fig. 2 is included in this group merely to show the appearance of this type of tool when closed ready for operation.

A Jig with a Double Wedge and One with a Swing Clamp

The jigs shown in Fig. 4 need very little explanation. The one to the left in this halftone is constructed to drill two brackets, right and left hand, at the same time. A piece of work is shown in one side of the jig at *A* and the bracket to be drilled in the other side is shown at *B* at the front of the jig. A wedge *C* which straddles the central web of the jig when adjusted by the nurled nut is forced up under both right- and left-hand brackets, thus holding the work firmly against the upper ledge of the jig while it is being drilled. A swinging arm *D* is provided at each side, which when clamped by swinging bolt and nut *E* holds the work in position sidewise.

The jig at the right-hand side of Fig. 4 is for drilling holes through the body of

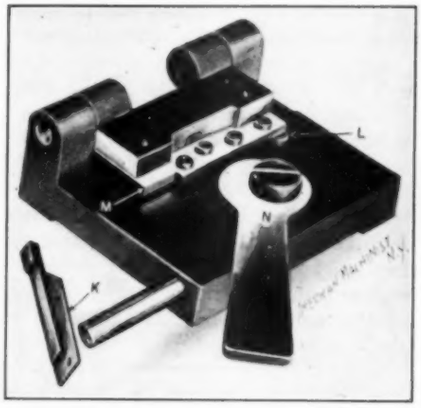


FIG. 7. JIG FOR DRILLING A STEEL BLADE

the casting shown at *F*, and also for drilling a small oil hole in the bearing formed at the top of the goose neck *G*. The work fits a recess turned in the face of the jig and when put in place the loose swinging clamp *H* is brought down and the T-slot *I* in its inner face is engaged by the head of a bolt *J* operated by a wing nut at the back of the jig. Thus the work is readily clamped to the face of the jig. The series of holes drilled in the swinging clamp *H* are sufficiently large to allow the drills which are guided by bushings in the body of the jig, to clear the clamp when passed through the work. The bushing for the oil hole at *G* is carried by a small post fitted to the jig in the manner indicated. The drawing, Fig. 5, gives a good idea of this jig and the manner in which the work is held in place. It also shows the spring which tends to force the clamp bolt *J* forward when the wing nut is released. Fig. 6 also shows the work in detail.

Other Jigs with Quick Acting Clamps

Figs. 7 and 8 illustrate another jig designed to permit work to be quickly located, drilled and removed. The work is shown in both the photograph and drawing and the operation consists in drilling four small rivet holes in a thin wing projecting from the narrow rectangular body.

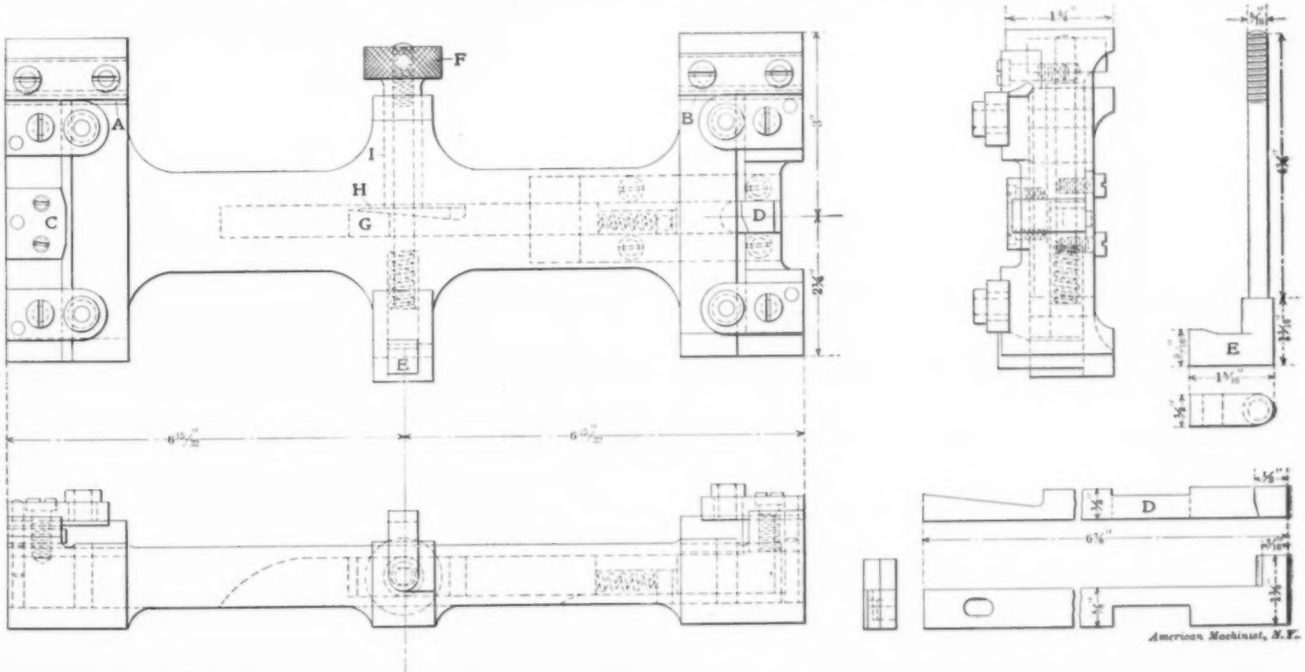


FIG. 9. JIG FOR DRILLING A FLAT PLATE

In this case the drill bushings are carried by a leaf which is not clamped down by an independent lock of any kind but is, however, held in closed position by the action of the eccentric lever which clamps

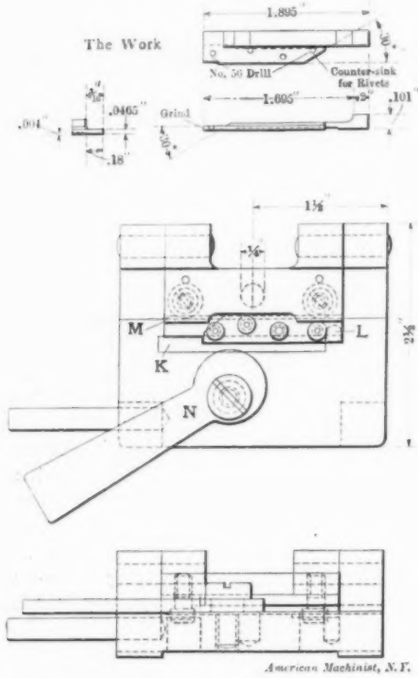


FIG. 8. CONSTRUCTION OF JIG FOR DRILLING A STEEL BLADE

the work in place. The work as seen at *K*, Fig. 8, when located on the jig has one end lying against the stop pin *L*, while one side of the body rests against the lower ledge of the jig leaf *M*. This ledge is considerably lower than the hinge pin upon which the leaf is swung and when the clamping lever *N* is operated it not only forces the work back against the ledge under the leaf but also presses it endwise against the stop pin *L*. The pressure against the leaf, of course, tends to draw the latter down tight, holding it in place during the drilling operation. The pieces drilled in this jig are accurately milled to thickness and with the face of the jig wiped off clean there is no opportunity for the leaf to assume any position except the correct one.

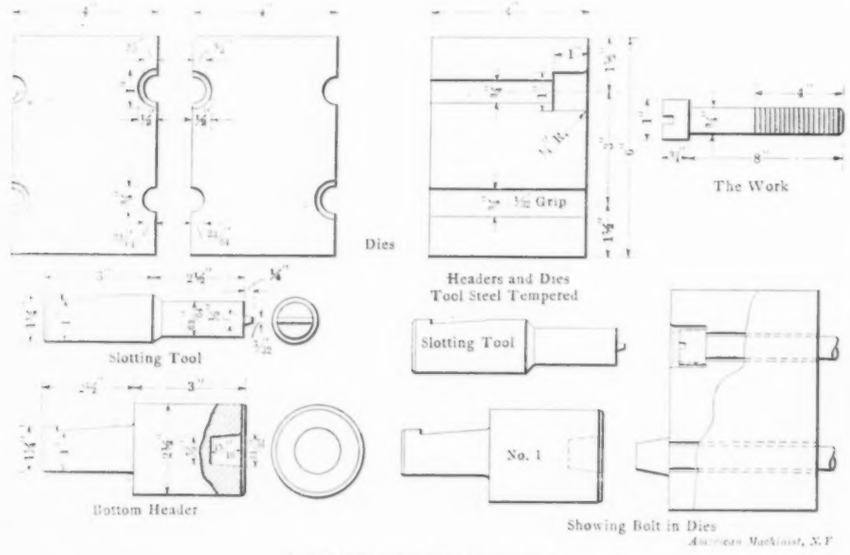
Fig. 9 illustrates a jig for drilling four holes in the corners of a flat plate which is about 11 inches long by 4 inches wide. The work is slipped in this jig against stops *A*, *B* and *C*. There is a spring-actuated bolt at *D* which presses the work tight against the stop *C* and another bolt at *E* which is drawn up by a nurled nut *F* to press the work against stops *A* and *B*. The inner end of bolt *D* is milled to the form of a reversed wedge *G* against which bears a wedge *H* which is acted upon by a sleeve *I* when nut *F* is tightened to draw hook bolt *E* against the side of the work. It will thus be seen that when bolt *D* is forced against the work by its spring the action of tightening bolt *E* by nut *F* will grip bolt *D* firmly by means of the wedge surfaces so it cannot withdraw from the work. This means then that the simple tightening of one nut, *F* locks the work at both sides and ends, while loosening the same nut releases the work at once.

A Set of Bolt Heading Dies

By F. O. Means

The sketches show a set of dies for making fillister-head bolts. We recently finished an order for 500 bolts of this kind made of open-hearth steel ranging from 4 up to 10 inches long. We headed the entire 500 in 2½ hours. The dies need little explanation. We used 47/64 round open-hearth steel. The stock is placed in the bottom groove and given one blow with header No. 1, which gathers the stock. It is then placed in the top groove and given a second blow with the slotting tool, which shapes the head and also makes the slot in the head. Two strokes of the machine finish the bolt.

The dies can be used in any heading machine. It is needless to state that the stock must have a good soft forging heat, as the life of the tools depends upon this.



A SET OF BOLT HEADING DIES

Japanese Machinery Imports for 1907

By Archibald J. Wolfe

From official Japanese statistics of machinery imports for 1907, a most remarkable increase appears to have taken place in these imports. The figures are all the more interesting to manufacturers of machinery as the classification in this last issue of statistics has been more specialized than is usual with such statistics. Imports of machinery into Japan for 1907 amounted to $14,138,000 or 49 per cent. ($4,709,000) more than in 1906. These are easily record figures and are 112 per cent. ($7,454,000) in excess of the average for five years preceding.

The following table shows the figures for the different kinds of machines and is taken from the customs returns. These machines have never been previously classified in Japanese official statistics and afford the first official idea as to the comparative imports of various classes of machinery.

Spinning machinery:	
Cotton	$1,434,000
Wool	25,500
Other	501,500
Electric machinery:	
Dynamos and electric motors	904,500
All other	393,000
Steam boilers	747,000
Steam engines and parts	689,000
Pumping machines	555,000
Lifting machines	548,000
Turning lathes	518,000
Steam turbines	513,000
Papermaking machinery	413,000
Weaving machinery:	
Cotton	176,500
Wool	165,000
Other	155,000
Mining machinery	97,000
Screwing machines	95,000
Hydraulic motors	91,000
Slotting machines	74,000
Distilling machinery	54,500
Telephones	53,500
Knitting machines	49,500
Typewriters	41,000
Steam hammers	40,000
Beer-brewing machinery	40,000
Shaping machines	37,500
Ice-making machinery	29,500
Sewing machines	383,500
Drilling and boring machines	347,500
Gas engines and petroleum engines	280,500
Planing machines	234,500
Sawing machines	192,000
Printing machinery	149,000
Milling machines	142,500
Hydraulic presses	126,000
Cotton printing machinery	22,500
Shoe-making machinery	22,500
Diving apparatus	16,000
All other machinery	3,881,000
Total	$14,138,000

IMPORTS OF MACHINERY IN JAPAN DURING 1907.

Practical Letters from Our Readers

A Round Table Discussing Details of Modern Machine-shop and Drawing-office Methods, Practice and Economy

WE PAY FOR USEFUL IDEAS

Turning Steel Gas Engine Cams on the Lathe

After repeated failures to get satisfactory results from chilled castings it was decided to make the cams for high-speed, vertical cylinder gas engines from steel forgings. The greatest difficulty in the way was to find a cheap and satisfactory method of machining the cam faces to the required shape.

The method adopted, as here described, and shown in line drawings, proved satisfactory in every way, so that now, hardened and ground cams can be produced of any desired shape as readily and almost as cheaply as if their profiles were regular. In Figs. 1, 2 and 3 is shown an exhaust cam on its arbor as being turned on its face. The cams are bored, faced and turned—exclusive of the face—on other lathes and keywayed before being brought to this machine for turning the face.

The cross slide of a Lodge & Shipley lathe was removed, and in its place was fitted the cast-iron slide *A*, Figs. 1, 2 and 3. The top of this is machined to receive the roller brackets *B* and *C*, and also the top slide with the tool holder belonging to the machine. The roller brackets are castings planed on the bases to fit slots in *A* and bored at exactly the same hight as the center of the lathe mandrel to receive the hardened and ground pins *D* and *E*, upon which are mounted hardened rollers *F* and *G*, each ground exactly three inches in diameter. The brackets *B* and *C* are fixed to the slide *A* by bolts *a b* and *c d*, respectively. Means for adjusting the back bracket *C* are provided in the dog *H*. This is a steel piece with a head to fit in the T-slot and is capable of being fixed in any desired position along its length by forcing the set screws *e* and *f* against the top of the slide, when the adjusting screw *g* may be brought into use to set bracket *C* into place. Two cams, *I* and *J*, mounted on the arbor *K* and located radially by the feather *L* running the length of the working portion of the arbor, longitudinally by spacing collars *O* and *P*, and fixed by nut *N* (which also fixes the cam to be turned) serve to impart the desired movement to the slide.

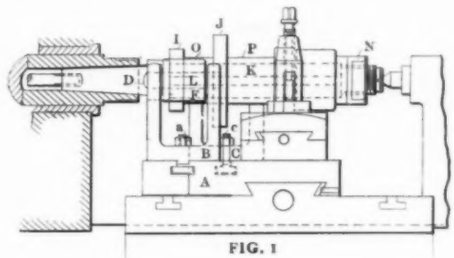


FIG. 1

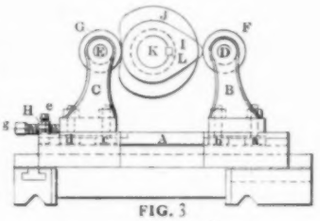


FIG. 3

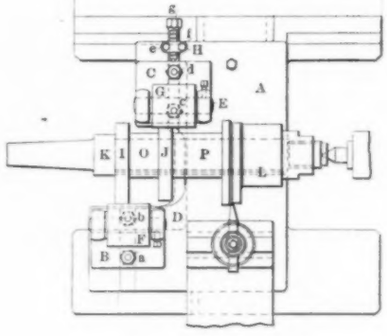


FIG. 2

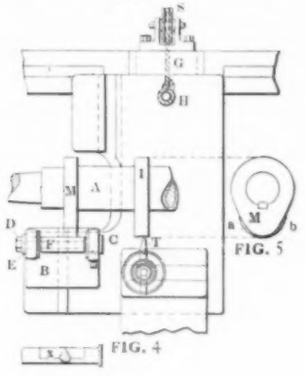


FIG. 4

FIG. 5

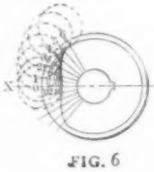


FIG. 6

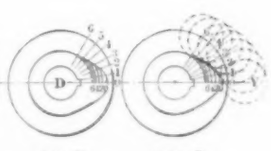


FIG. 7 FIG. 8

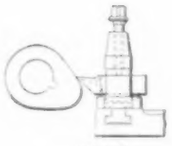


FIG. 9

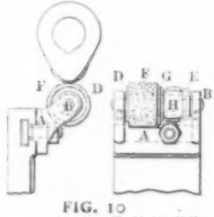


FIG. 10

American Machinist, N.Y.

TURNING GAS-ENGINE CAMS

With the motion cams arranged and made as shown, each roller is in contact with its cam during the whole revolution, thus rendering the usual weighted chain or rope entirely unnecessary. The method and tools employed to produce these two motion cams is the most interesting part of the job:

To start with a master cam in profile exactly like those it is proposed to make is produced. This is made from a steel forging, bored and keywayed to fit the cam arbor, and faced to about 1 inch thick. It is then marked out and shaped to the lines, then filed up square and smooth. The shape of this will be about as shown by the inner lines of the sketch, Fig. 5; also by Figs. 7 and 9. Two other forgings are then procured in shape similar to *I* and *J*, Fig. 3. These are bored and faced, then keywayed in position, as shown, the keyways being located with sufficient accuracy to insure the faces tooling up.

The lathe is then set up, as shown in Fig. 4, for turning the first motion cam *I*, Figs. 3 and 4. Here the back-roller bracket *C* and adjusting dog *H* (Fig. 2) are not shown, as they are not required for this operation, while in place of the three-inch roller in front bracket *B*, is substituted one *F* as small as practicable; that is, one inch in diameter, running on a pin one-half inch in diameter. This pin *C* has a head made to fit the 1-inch hole in bracket *B*, while the small end is threaded for nut *D*, which holds supporting bush *E* in position, as shown. Both the pin *C* and the roller *F* are hardened and ground.

While the master cam *M* is revolving when the motion cam *I* is being turned by tool *T*, a weighted cord *G*, anchored to a screw *H* in the slide and running over sheave *S*, keeps the roller *F* in continuous contact with the master cam *M*, thus causing the tool *T* to turn the cam *I* to an outline resembling the cam *M*. But *I* will not be just like *M* because *M* works against a roller one inch in diameter, while the tool operating on *I* has a point. The difference in shape is about as shown in Fig. 5, referred to above, where the master cam is mentioned as being shaped to the inner lines; the outer lines represent the resulting shape of the motion cam *I* when it has been turned, as described.

To get better results the roller *F* and pin *C* are replaced by a pin that is as nearly a knife edge as is practicable, shown at *X*, Fig. 4. The section in this detail shows the shape of the pin along that part which comes in contact with the cam face. With this pin in position the lathe is revolved slowly and the weight at the back reduced to a minimum; the operator assists the slide back to prevent the face of the master cam *M* from becoming scored while the tool removes the fullness shown in Fig. 5, thus making the two cams alike.

But it is intended to turn a cam of the same shape as *M* from a motion cam in contact with a 3-inch roller. Upon examining the motion cams *I* and *J*, shown in Fig. 3, it will be seen that the front cam *I* is far narrower at the nose than that shown in Figs. 5, 7 and 9. By referring to Figs. 6, 7 and 8 the reason for this will be readily understood. Figs 6 and 8 show the outlines of the cams in contact with rollers 3 inches in diameter, which would produce the shape shown at Fig. 7 and at Fig. 9 with a pointed tool. These cam outlines are developed on paper in a very simple manner.

The outline of the cam it is proposed to make is first drawn and about it is circumscribed a circle of convenient size. Two equal circles are also described on the same line *X Y*. The portions of the circumferences coming within the region of the irregular part of the cams are then divided into any number of equal parts commencing on the line which is drawn to coincide with the largest radius of the cam (see 0, 1, 2, 3, 4, 5, 6 in Figs. 6, 7 and 8). Lines are then drawn from the center of each circle through each division, incidentally intersecting the cam outline in Fig. 7. With the compass point at center *D* these points of intersection are projected to the base line *X Y* and transferred to each circle in the order shown in the sketches, and from thence projected to intersect with the radiating lines coinciding with those in Fig. 7. With the point of the compass on the radiating lines, arcs of radius equal to the roller are then described to pass through these points of intersection. A line drawn fairly to touch these arcs will conform to the shape of the derived motion cams. The development of one side only is shown in the sketches as both sides of the cams are symmetrical in this case.

These shapes are accurately produced in the lathe by grinding the motion cam *I*, Fig. 4, with an emery wheel of exactly the same size as the rollers. This is mounted on a tool holder, as shown in Fig. 10, in plan and elevation. The wheel is driven from overhead works arranged for this purpose. The grinding attachment, as shown, consists of a casting *A* fixed to the tool-post slot by a ⅞ bolt. It is bored at the exact hight of the lathe center to receive the hardened pin *B*. The phosphor-bronze sleeve *D*, which has a flange at one end and is threaded at the other end to take the steel nut *E*, is bored a good running fit for the pin *B*. Upon *D* is slid the emery wheel *F*, washer *G* and pulley *H*, which are all fastened securely to the sleeve by means of the nut *E*. Effective means of lubricating the bearings are provided but not shown in the sketch.

With this grinding attachment in position in place of the tool and holder (see Fig. 4), the high places *a* and *b*, Fig. 10, were readily removed. The motion of the carriage is guided as before, with the knife-edge pin *x*, Fig. 4, in contact with the master cam *M*. But it is unnecessary to run the lathe by power through the whole revolution, so the spindle is given a backward and forward motion by hand past these high places until they are removed, then a few complete revolutions until the wheel cuts all around, when the first-motion cam is reduced to the required shape, as shown at *I*, Fig. 3, and also in Figs. 8 and 10.

Having produced the first-motion cam, it is comparatively easy to produce the second as at *J*, Fig. 3, and the method of procedure is as follows: The master cam *M* on arbor *A*, Fig. 4, is replaced by the first-motion cam, just produced; while the sceond cam to be machined is secured in the same position as that formerly held by the first-motion cam as *I*, Fig. 4. The front bracket *B* is removed from its place on the slide, while the back bracket *C*, Fig. 2, is fixed in its place in the back slot of the slide. Means are provided to keep the roller *G* in constant contact with the first cam when the spindle revolves while the tool *T*, Fig. 4, turns the second cam approximately to shape. It is, of course, ground to correct shape with an emery wheel exactly the size of the roller it has to work with, after turning. The two cams are now ready for use, when arranged, as shown in Figs. 1, 2 and 3.

It was expected that it would be necessary to harden the motion cams and regrind their faces, but it was decided to try the first pair soft, when the wear was found to be scarcely discernible.

It is often desirable to grind the faces of some cams after they have been case-hardened. No additions to the tackle here mentioned are necessary to do this, for with the master cam working against a roller of the same diameter as the emery wheel, the exact shape will be procured, the roller and cam being kept in contact by means of the weighted cord, as shown in Fig. 4.

Fig. 9 is intended to show the excessive clearance required on the turning tool. Difficulty was at first experienced with the tool, but after some experimenting a shape was evolved which would take a cut ¼ inch deep 1/64 feed at 100 feet per minute surface speed. Thus a cam 5 inches diameter can be turned on the face in about 20 minutes, including fixing on the arbor. To obtain correct results it is absolutely essential that the point of the tool be set exactly to the same hight as the lathe centers.

Loughborough, Eng. G. H. GIBBS.

A Fixture for Bending Flat Stock on Edge

This bending device is for forming out of flat-steel rod, as shown in Fig. 1, the shape shown in Fig. 2. In the ordinary course of events, the shape shown in Fig. 2 would be stamped out of solid metal, thereby causing a tremendous waste of material. The fixture shown in Fig. 3 does away entirely with this waste, and work can be turned out in great quantities owing to the simple method of forming the two bends.

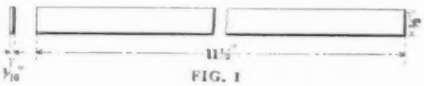


FIG. 1

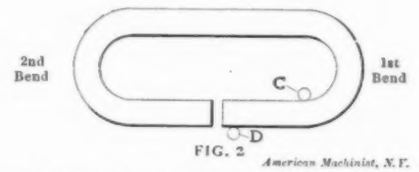


FIG. 2 *American Machinist, N.Y.*

THE BLANK AND THE FINISHED BENDS

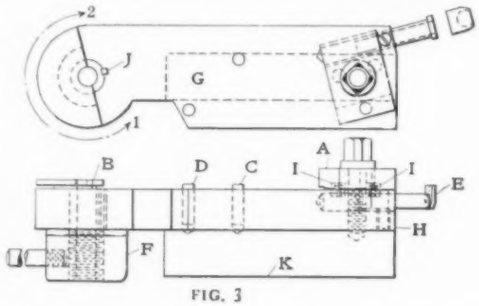


FIG. 3

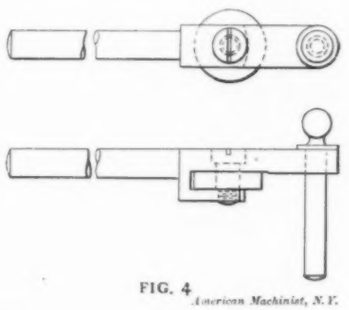


FIG. 4 *American Machinist, N.Y.*

BENDING THE FIXTURE

In forming the first bend, take the rod and lay out a center line; then place it under *B* and between *C* and *D* so that the center line is at *G*. Adjust the stop *E* and lock with the set screw *H*. Clamp the rod down with *A*, tighten *B* with *F* and form the first bend with the fixture

shown in Fig. 4; the roll working from position 1 to 2.

The second bend is made by placing the rod in the position with relation to the pins *C* and *D*, shown in Fig. 2, and tightening up *B* as before, the roll in this case working from position 2 to 1. The work is then taken off the fixture by loosening up *F* and turning the work until *B* will slip through the center. *I I* are two springs for keeping the clamp *A* up when not in use. *J* is for keeping *B* in position and *K* is for allowing the fixture to be held in a vise.

New Haven, Conn. JOHN R. JARVIS.

What Is a Good Running Fit?

The publication department of the AMERICAN MACHINIST is sending out small pocket data tables showing the proper allowances for running fits, and there is an article on the same subject at page 234, of the AMERICAN MACHINIST. It seems to me that a good running fit depends entirely upon circumstances and the conditions under which a shaft or axle must run. I wrote to several concerns on the subject and it may interest your readers to know what is considered good commercial practice for various lines of machinery.

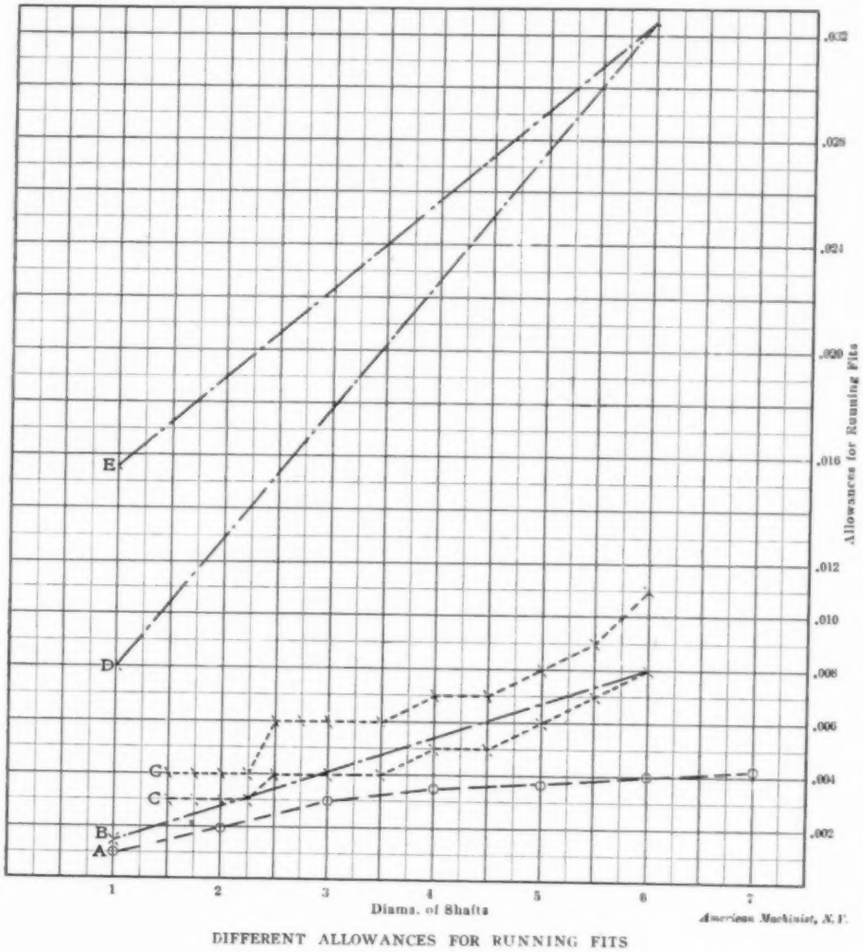
One of the leading electric manufacturing companies, who asks that its name be not given, writes as follows:

"Referring to your letter of recent date in regard to running fits, we would say that our factory advises that the standard clearances which we allow in thousandths are shown in the following table:

Shaft Diameter.	Clearance.
1½ inches	3 to 4 thousandths
1¾ inches	3 to 4 thousandths
2 inches	3 to 4 thousandths
2¼ inches	3 to 4 thousandths
2½ inches	3 to 6 thousandths
2¾ inches	4 to 6 thousandths
3 inches	4 to 6 thousandths
3½ inches	4 to 6 thousandths
4 inches	5 to 7 thousandths
4½ inches	5 to 7 thousandths
5 inches	6 to 8 thousandths
5½ inches	7 to 9 thousandths
6 inches	9 to 11 thousandths

The Dodge Manufacturing Company, of Mishawaka, Ind., one of our leading manufacturers of power-transmission machinery, states:

"We have different standards for different classes of work for running fits. Our ordinary bearings vary from 1/64 inch for 1 inch to a little over 1/32 for 6 inches. Our clutch sleeves, which are babbitted, run very much closer, varying from 0.008 to about 0.0015 inch. Our loose pulleys are sometimes made as close as 0.003 inch on the smaller sizes. A good standard on loose pulleys is about 1/64 on a 2½-inch hole and varying proportionately for diameters above and below that. You will no doubt, find this very much freer than most people recommend, but we find that in the general trade there is more difficulty in having a little too tight a fit than there is in having the fit a little too loose."



DIFFERENT ALLOWANCES FOR RUNNING FITS

In a different line of machinery, the Watt Mining Car Wheel Company, of Barnesville, Ohio, makes a very liberal allowance for running fits as follows:

"We allow 1/16 inch play in all the different sizes of wheels. For instance, if the spindle on a 2-inch axle is exactly 2 inches, we bore the wheels 2 1/16 inch in diameter, or 1/32 larger all the way round. This will apply to both round or square axles.

"The endwise play on a wheel is 1/16 inch more than the distance through the hub of the wheel. For a wheel 6 inches through the hub, the spindle on the axle would be 6 1/16 inch long. This applies to square axles, while on the round axles we always place a ⅛-inch washer between the wheel and the linch pin, which makes the spindle on the axle 6 3/16 inches long when the wheel is 6 inches through the hub."

I have plotted the various fits: Curve *A* shows the allowance as given by your card; curve *B*, the Dodge sleeves; *C C*, the electric companies' allowance; *D*, Dodge loose pulleys, and *E*, Dodge bearings.

The practice of one large fan blower concern allowed from 0.005 to 0.0010 inch clearance on fan journals from 9/16 inch up to 2 7/16 inches. This work, as everyone knows, calls for very high speeds and heavy belt tensions, and some of the bearings have been in use over 20 years.

In our practice we allow from 1/64 to 1/32 inch for ordinary bearings, and in the case of certain small wheels, idler bearings, sprockets, etc., we allow from 1/32 to 1/16 inch play on a 1¼-inch shaft, and find that this is about right.

Does not a good running fit depend upon speeds, conditions of service, and quality of lubrication?

Covington, Va. WM. SANGSTER.

Lubrication of Clockwork by Kerosene Vapor

The users of delicate and intricate mechanism composed of clockwork or similar devices, may be interested in the following kink:

I had a clock mechanism which refused to operate; the trouble was, undoubtedly, due to lack of lubrication and dirty bearings. There was not time to disassemble for a proper cleaning, and a lady, hearing it discussed, suggested taking a woolen cloth, saturate it with kerosene oil, lay it near the mechanism and close the case. Although somewhat skeptical of the effectiveness of this plan, I tried it. In a few hours the wheels began to turn and have run steadily ever since. Probably

the light vapor from the oil provided the slight lubrication required.

Rochester, N. Y. RALPH W. DAVIS.

[More probably the vapor "cut" the old gummed oil which acted as a brake. A common method of cleaning clocks is to wind them up and immerse in gasolene or kerosene, but it's not the right or the best way.—ED.]

An Efficient Buz Saw Safety Guard

Men who operate circular saws prove to be in the greatest danger of being injured, as the insurance companies set their rate the highest. So serious had this become that the State of New York has enacted a law compelling employers to place some sort of a guard over their saws.

Being ordered by the State inspector to so protect our saws, with the hint that to comply with the law something must be done (whether the workmen used it or not), this question came to mind: Shall we scheme up something to comply with the law, or something to keep the men's hands, so far as possible, out of danger?

Either because I have some sympathy with the men, or because I like to tackle difficult problems, the latter plan was adopted. There were two cases in the shop, a Baxter D. Whitney dimension saw, and a very good modern splitting saw in the foundry-carpenter shop. The Whitney machine is so far hopeless, but for the other the cuts show the result.

The conditions in this case are these: The man must be able to do any kind of work he could do with the guard off, slit lumber in the ordinary way, bevel cross-bars for flask copes, split plank or flasks of any width or length. There was to be nothing about the rig that the workman could take off and hang up, and no change that he could not make in a second of time. It must protect the saw, keep pieces off the top of the saw and, so far as possible, keep the sawdust down.

The side view shows how the guard swings out of the way as the plank is pushed up to the saw, the counterweight so nearly balancing the guard that a slight extra force is just enough to steady the work.

The sheet-steel blade *A*, slightly thinner than the saw, holds that part severed from the plank from being caught by the saw. And the top ledge and angle, shown in dotted lines, throws the sawdust down.

The operator can, by pulling on the screw handle *B* raise the guard to any point and lock it from falling any lower; but it only locks a stop, which still leaves the guard free to lift higher. For instance, he may have a lot of 1¼-inch plank to split, and raises the guard to the right hight and makes the stop fast, then there may come a plank with a crook or hump on it, which will go through without resetting the stop, as the guard can lift over it.

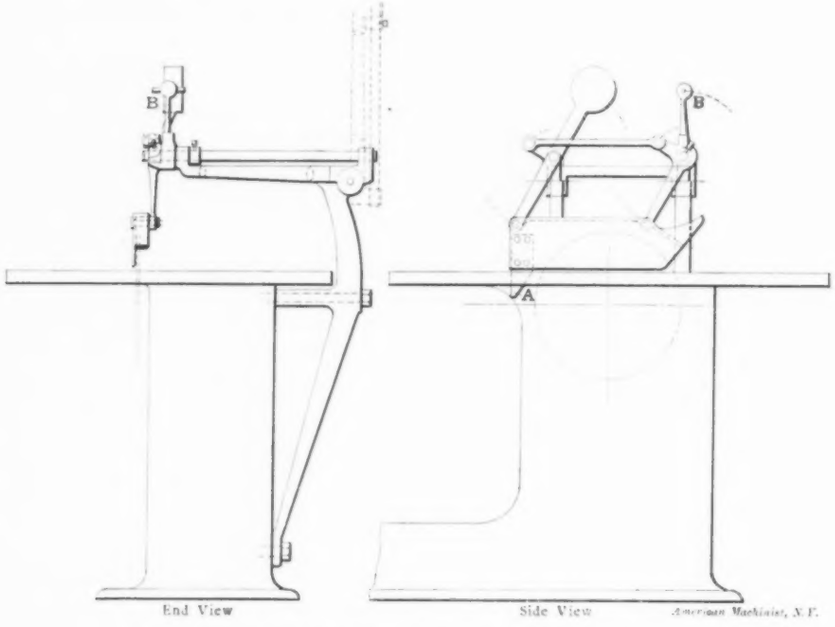
If a plank or timber to be sawn is deeper than will pass under the guard, the whole thing can be tipped up out of the way on the hinge joints shown in the end view. This view shows how the rig is secured to the frame of the machine, an essential feature, as the blade *A* must always come in line with the saw.

The old-time wood-frame saw bench often had a blade come up from below, but had to be abandoned when the lifting saw was adopted, and often before, owing to the difficulty in keeping it in the proper place on the wood frame. This rig permits of tipping the table as before.

The rig apears to be a good one, as the men do not tip it out of the way all the time. They cannot take it off and hang it up. It costs, as do all good things, but if it saves one man's hand it's worth the money.

JOHN E. SWEET.

Syracuse, N. Y.



AN EFFICIENT BUZ SAW SAFETY GUARD FOR A MODERN SPLITTING SAW

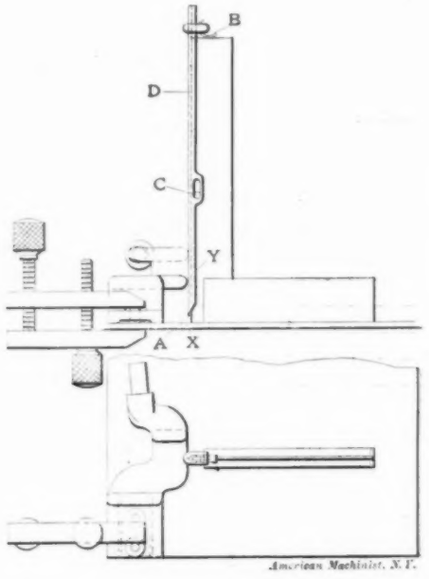
A Simple and Accurate Casting Outliner

The outliner was designed to make the process of making a drawing from an irregular piece easier and less chance for errors in dimensions.

By clamping the piece to be detailed to a surface plate or any smooth, flat surface, so that a plan of the piece is same as the view desired, we can prick, on paper placed under piece, with the needle *D* the true outline. From this outline dimensions can be laid off to any scale desired.

A shows the needle a little above the surface of the paper, being held up by the spring *B* against the pin *C* in the square blade. With slight finger pressure on top of the needle, we prick the paper at the point *X*, a point directly under *Y*, on the casting. By repeating this at various points along the edge of the casting, we get an accurate plan view of it on the paper.

Lynn, Mass. E. J. WILSON.



A CASTING OUTLINER

Discussion of the Previous Question

Letters from Our Readers Showing How Many Men of Many Minds Look upon Various Subjects Opened up in Previous Numbers

WE PAY FOR THESE ALSO

Hardening and Cooling Speeds of Steels

James Steel, in his article on page 492 entitled "Recalescent Point in Hardening Tools," gives some information that is to the point, and it is just what I have been hunting for. It is very apparent from his article that he has full practical as well as theoretical knowledge of this subject, and it also seems that he is willing to share his knowledge with others, and he certainly is able to convey his information in an understandable manner.

His article seems to have been brought out, at least partly, by one written by me, and mine was inspired by the fact that experiment had shown it to be easy to determine the recalescent point by the use of a magnet.

While I have done some experimenting with a compass for the kind of work done in the shop, I much prefer a small horseshoe magnet. It is not so sensitive as the compass, but neither is it so subject to influences which do not come from the piece of steel being heated. The magnet can be used, for instance, and will tell if that end is above the critical point or not. I have not been able to get such information by means of the compass.

Mr. Steel's article shows us that all articles are not to be dipped at the same heats, or in other words, at the same temperature distances from the critical point. I am not entirely clear as to this point, but if I get his meaning right I understand that if several identical tools be made from different steels these tools may each require to be heated to a different degree from the critical point to get the best results.

This being so, I would ask if his experience has shown any general rule for this?

As it is a fact that the critical point is higher in low-carbon steels than it is in high-carbon steels, up to a certain point, therefore, the temperature of low-carbon steel, heated for hardening, would have to be higher than it would need to be for higher-carbon steel; but would have to be higher above the critical point or not.

I understand also that different-sized pieces of the same steel have to be heated to different temperatures, and thus the larger the piece the higher the temperature should be, would be my natural conclusion.

In the information which I would like to get I am not seeking information as to differences which have to be made because of the shapes into which the steel has been made. I understand that often the hardening process has to be modified because of such differences, or at least it is.

I see that John Sirius, on page 753, gives some light on the matter as he sees it, and that he also refers to the very valuable article by E. F. Lake. In Mr. Lake's article he says, "To harden steel, therefore, it is necessary that the heating produces a change in the structure, and that the quenching which follows the heating will retain a whole or a part of the elements produced by this change of structure. It is, therefore, necessary, as in annealing, that the temperature of the steel be raised to a point slightly above the point of transformation." Farther along he says: "This coarsening of the martensite, the reduction of both the tensile strength and elongation and the crystallization spoken of some few paragraphs back have led to the conclusion that in practice 40 degrees Fahrenheit above the highest point of transformation is the extreme limit that steel should be raised to obtain the best results in hardening. The same figure also holds good for annealing."

These statements seem to be positive, and would indicate that a piece of steel should be quenched as soon as it has been heated beyond the critical point. If this is positively indicated by the fact that it is no longer magnetic, then it should be quenched as soon as it no longer is able to deflect the needle of the compass or stick to the horseshoe magnet, for then the change would be complete and the range of 40 degrees would not leave much margin.

All the mystery thus having been taken away from the art of hardening, and the magnet furnishing a means of knowing the proper heat, it remains to properly quench and temper the steel.

Following through Mr. Lake's article in the part relating to the various baths it is found that perfect hardness could be obtained only by instantaneous cooling which, of course, is a practical impossibility. The degrees of hardness are caused by the speed of cooling. If I am right in understanding his statements the various baths owe their value entirely to their effect on this rate of cooling. Owing to their shape some pieces will not stand extremely rapid cooling. Owing to the uses to which they are to be put some pieces do not need to be extremely hard. Such things make it necessary to modify the bath. The quickest cooling bath gives, according to the construction I place on Mr. Lake's statement, hardness, and the slowest cooling gives toughness. The bath to be used may depend to some extent on the point between these two extremes that is aimed at.

Whether or not these conclusions can be looked upon as having been definitely established, like the law of falling bodies, for instance, and that any failure that we may have we may be sure comes from the wrong application of them and not from any errors in the laws themselves I do not know. I would like to be sure.

There is one little statement that is in the latter part of John Sirius' article that, for the sake of some of the younger readers who may be interested in these subjects, I would like to call attention to.

After telling of the extremes of temperature at which he had found steels hardened he says: "So I think someone was stringing Mr. Osborne."

Many and many a time I have been strung, and one fellow in particular has done quite a lot of it, and the stringing that he has done has been the worst kind of stringing. When Osborne goes to stringing me it is an act of friendship for Sirius, or Lake, or Dixie, or some other good Samaritan to give him an energetic jolt.

I have read that certain elements change the critical point in steels so that some steels now have critical points below zero. If there was a book published that gave the names and characteristics of all of the steels that have ever been made for tool steels, I would not care to spend the time to read it. I am afraid that it would take me the rest of my natural life. Perhaps every one of these varieties of steels have had critical points, even if we didn't know anything about such things awhile ago.

Boys, it is not safe to turn a thing down and say it is an absurdity, or impossible because you do not know anything about it, even if you find it contrary to your experience and knowledge unless you know all about the subject to which it relates, for the future may show that you have been "stringing" yourself on the subject, and self-stringing is worse for your growth than it is to have others do the stringing.

It would seem that the ideas which I have taken from Mr. Steel's article did not entirely agree with those which I have taken from Mr. Lake's as far as they re-

late to the heating of the steel. In thinking the matter over I have tried to think of what happens when a piece of steel is quenched. The bath takes the heat from the outside of the steel, while the heat that is in the inside flows to the outside. The outside is thus being cooled from one side and heated from the other. With a bath kept at an even temperature the rate of cooling would still vary with different sized pieces, for if the size (diameter of a ball, for instance) is doubled the amount of heat that has to pass through a given sized area of the surface is also doubled, and it seems certain that the more heat that has to pass out the longer it will take it to pass out.

If we had a bath that would absorb the heat as fast as it came to the surface, then the cooling would be as fast as the heat could pass from the interior to the surface. Unless the interior gave up its heat with very great rapidity it could not be perfectly hard. Naturally this rapidity decreases as the diameter increases, and so the degree of hardness decreases and we find that the interior of a large ball is not very hard.

The surface of the ball may have been cooled so rapidly that it is intensely hard from having been cooled with sufficient rapidity through the critical point, but owing to the fact that heat is flowing from the interior the surface is not cooled below a tempering temperature, and so this hardness is tempered. The larger the ball the more time and heat there is to do this tempering and so the softer the surface is.

While it seems to have been settled that a piece is harder in proportion to the rapidity of cooling, yet I have never seen anything that gives an idea of what the rapidity is for good hardening. For instance, should the heat be extracted through the critical range in one second, or in a tenth of a second, or in a hundredth of a second? Or if extracting it in a hundredth of a second gives perfect hardness what degree of hardness do we get from extracting it in a tenth of a second? Do we get the greatest rapidity of cooling through the critical range when starting from a point just above that range, or do we get added rapidity by starting from a higher heat?

These are only a few of the very many questions that have puzzled me. While hardness has been referred to, it is not everything in the manipulation of steel. I have found that heat treatment changes the properties of steels that are of too low carbon to be used as tool steels as radically as it changes the tool steels. I know even less about how to get the best results with such steels than I do about how to get it with tool steels, although I hope by a careful use of the microscope to know enough to make use of the fact that such changes can be brought about.

Oil City, Penn. W. OSBORNE.

Comparative Tests of Two Shapers and Other Discussion

The May 6 issue contained an unusual number of items in which I found special interest and on each of which I desire to make brief comment. Mr. Noble's report of tests of square lock and bevel slides for shapers, page 732, is something that we have all been looking for for years. The conclusions reached are not those that I expected to see, as I formerly believed that the square lock would be capable of doing better work than the other. It would help some if drawings of the gibs and packing could be published, as much depends on the means furnished of taking up wear and resisting upward forces. In the usual type of square lock where the upward pressure on the gibs is resisted by cap screws which bolt them to the frame of the machine there is a liberal chance for spring in the bolts themselves, which, if the bevel slide is planed out of the solid, would not be the case in the latter form.

I was struck by the idea of relieving the middle of the bearing surface on the frame. We do this thing here in the East on lathe tail spindles, head and tail stocks on lathes where they bear on the vees of the bed, but I had supposed that shapers were universally made with solid bearing surfaces the whole length. According to Professor Sweet the two surfaces in contact should have the same length for equal wear. While I do not entirely indorse the idea, I do think that in the case of a long ram reciprocating in a short bearing if I were going to do any relieving I would do it in short spaces on the ram itself, instead of on the already short bearing in the frame. If good workmanship is available I see no reason why a bearing over the whole length would not be an advantage. Another point that would have a considerable influence on the rigidity of the ram is the means of supporting the packing, whether set up by means of little pointed set screws or by endwise motion on a taper seat with a metal to metal contact all over.

CHART VS. EQUATION

If there ever was a case where the question of charts vs. equation made a strong showing for the chart it is in Messrs. Smith and Poliakoff's paper on twist-drill tests, page 739. The equations mean nothing until plotted, then the curves mean everything. I think this tends to show that, where exact results are needed as a means of reaching some end, the equation is the more satisfactory; while, after we have once reached the end of our work the results when plotted are more easily comprehended and remembered. In this connection I might mention a case that recently came up. A friend of mine had a cubic equation to solve. I suggested to him that he substitute easy values in his equation and plot the result. He did so, discovering that within much wider limits than his work called for, the resulting curve was so nearly a straight line that a very much simpler equation in the first power was satisfactory. I like graphical representations because they keep in mind longer than equations.

LEAVING A MACHINE RUNNING WHILE AWAY

W. L. McL. has evidently been called down recently for letting his machine run while away from it, for at page 748 he tries to show that it is economical to let things smash occasionally. It is pretty difficult to make the boss see this at the particular time when the smash comes. The only safe way that I know is to have someone handy to stop things if anything goes wrong. The next best way is to have all grinding machinery, etc., close to the tool. The still better way is to have errand boys carry tools to the tool room to be ground and give the workman no excuse for leaving the immediate vicinity of his machine. In this case though it is possible to overdo the matter, for often a finishing tool will chatter when working on a poorly supported part, and require small changes in its angles to cure it. It is pretty tough also to be tied down to one place when everything is apparently all right on a cut running for an hour. Some foremen won't even let you read a book, to say nothing of whittling out a pattern for a tool or any other useful work.

A BELT DRIVE CHANGE

Mr. Anthony's belt problem, page 751, looks like a lot of work to get around a very small difficulty, but there seems to be no other way out of similar cases. Most of the difficulty seems to come in the twisting of the belt, which takes power as well as reducing the total tension on the belt. Of course, if a belt is twisted it tends to stretch the edges and compress the center. When tension is put on when the belt is used as a crossed belt the edges of the belt reach the breaking point long before the center is brought up anywhere near that point. I doubt if the additional length of belt, in itself, is any gain though many people seem to think that a long belt is all that is needed to make a satisfactory drive.

MACHINE-SHOP SAFETY DEVICES

Why do safety devices seem to originate across the water? Are we more reckless and do we hold life and limb cheaper? or are we so much more careful that we do not need them? I recall one place where I worked; we had a large planer whose table was nearly down to the floor level. We used to cross on that table day in and day out while it was running. Often there was only a foot at the end of the table beyond the work but we crossed just the same. In some 15 years no one slipped. I never crossed without thinking

what might happen if I got a leg down between the end of the table and one of the cross ties in the bed, and the planer hand was off talking with someone else. We think of aëronautics as being risky but I don't know that it is any worse than everyday life in a shop, and that is not a circumstance to the risk in getting to and from work. Then again, think of the number of people who die in bed!

Graduating Tailstocks

If Mr. Bean is going to have his tailstock graduated for the set over, he ought really to have an adjustable zero mark. There are very few lathes built that do not need one and fewer run in such a way that a positive stop is allowable. What is needed is one of these three-dimension charts, where one dimension gives you the set over for different positions of the tailstock along the bed, another, a correction for the distance the tail spindle projects and the third a correction for each man that grinds the centers. A cheaper substitute is to buy a universal grinder.

Springfield, Mass. Entropy.

Industrial Education

In the American Machinist, page 941, I noticed an editorial concerning the committee on industrial education of the Manufacturers' Association. Some impatience is manifest, excusable under present conditions, with the slow progress of the industrial-education movement toward a practical realization of the ideas expressed by various agencies advocating trade training. Doubt is expressed in the editorial whether our public schools can be of much use to our industries along trade educational lines on account of the supposedly enormous cost involved in fitting up the schools for trade schools.

Permit me to say that the trend for industrial and trade training is so recent, and is still in the experimental stage to such an extent that in justice to all concerned we, in the United States, cannot possibly expect more than has been done already which, it is true enough, is mighty little, if judged by the urgent needs of the manufacturer.

Two Educational Tendencies

Our whole educational system as well as our social spirit is not adapted to meeting the needs of our industrial conditions and, therefore, we are in a period of transition which, with any institution or organization, is unavoidably a period of trials, vexations and difficulties. However, two tendencies are making themselves manifest among those who are actively engaged in an effort to meet the educational wants of our industries for skilled workers. One tendency is in favor of what we might call the short-cut method of shop schools which serve purely individual needs for increased skill and productive capacity of local firms or railroad shops, without reference to the needs of other industries or the community in which the firm, having a shop school, is located, nor yet without any reference to the source of supply and preparation of those who are to furnish the desirable material for the successful shop school. The community in which an individual shop school is located is indirectly only, if at all, interested in the enterprise, considering it in the light of a dividend-increasing venture of a selfish nature and, therefore, not particularly inclined to make sacrifices in the shape of increased taxation to provide the necessary facilities in equipment and teachers demanded by the needs for suitable preparation of the material which must keep the shop school going. And it is obvious that the more a shop school is obliged to do preparatory work which ought to have been done in the common school, to that extent the shop school will cost more and be less effective for the purpose intended. To the degree that economic pressure demands in the future increased skill or knowledge, or both, to that degree the shop school will become more unsatisfactory in its results, or output, if you please, because of the relatively more inferior preparation of the available material.

The other tendency is to make our educational system preparatory schools for the masses of our industrial workers in the same sense and to the same degree, in their way, that the high school prepares for professional life and the grammer school prepares for the high school. If it is right and equitable to spend the taxpayers' money for the preparation of 10 nonproducers, why should it not be right to spend the taxpayers' money for the preparation of the 90 producers?

The Public Schools and Industrial Education

As the educational representative of a national industry I advocate taking the whole people into our confidence, thus making all the people interested in the vocational training of all the industrial workers. But I am not in favor of turning our schools into trade schools. I am not in favor of having our boys spend one or two or more years acquiring manual dexterity in the school which our bright American boys will acquire in six months in the shop. What I am working for for the school to do is give industrial education, that is, preparatory training for vocational life up to 16 years of age and then have the school supplement and complement the actual work in the shop by the school teaching that technical and theoretical part of a trade, in evening or half time, or shop schools, which cannot be acquired in the shop in learning the mechanical part of a trade or occupation. I would be in favor, though, of having the usual manual-training equipment in every school.

This would not cost so much. We cannot eat the cake and keep it. We cannot expect to get dividends and high wages and maintain a high standard of living without the proper standard of efficiency.

A few large corporations can maintain shop schools, but most of our industries cannot do that. They cannot afford the expense nor would it be practical.

If the city of Munich, Germany, not an industrial center as many of our cities are, can afford to support 48 distinct trade schools and 12 industrial schools, or one industrial school to every 8700 inhabitants, the population being 520,000, then why should a rich country like ours not be able to support the necessary number of the less expensive preparatory industrial schools? The superintendent of schools of Munich plans to have 72 distinct trade schools. In the editorial of the American Machinist the Fitchburg plan is favorably commented on. Well! By that plan the school is turned into a shop and the boys coming from the shop school are given credit when becoming apprentices.

Suppose there were 20 different trades in Fitchburg and every one should demand a school shop for preparation, would not that be expensive? And if Fitchburg could not afford that could each of the 20 industries afford to have a shop school? And if not, would eventually the school be compelled to assume preparatory work for vocations as a matter of self-preservation?

It being admitted that the school must take up some of the preparatory, or so-called industrial education, and this preparatory education being badly needed to hasten and perfect the specific trade education under whatever form, it seems to be desirable to get the schools to take up that work. And to this end I am bending my energies because I believe that the longest way round is the shortest way home in this case.

P. Kreuzpointner.*

[The plan whereby the public schools are to be made more useful by coöperating with and supplementing the work of the factories has our cordial approval as our readers must know. We can see no issue between our contributor and ourselves—Ed.]

An Anti-chattering Device

Referring to the anti-chattering device on page 451 will "Cadillac" kindly explain how the boy pulled off the face plate and put on a jaw chuck while "the shaft was still on the centers."

Birmingham, Eng. X

*Vice-president, Pennsylvania branch of the National Society for the Promotion of Industrial Education.

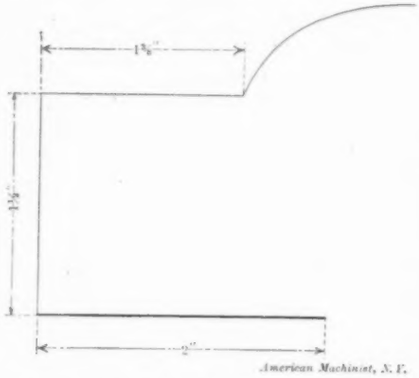
Comparative Tests of Two Shapers

On page 732 of the AMERICAN MACHINIST, some tests were published making comparison between the V and square gib for the ram bearings of shapers. While the tests were undoubtedly fair, as comparing the two shapers in question, they would hardly apply to the average square-gibbed machine. The V-gibbed machine was a standard back-geared crank shaper, while the square-gibbed machine was one made expressly for these tests, by the makers of the V-gibbed machine, and the results of the tests were published with their permission. We want to ask, would it not have been somewhat fairer to have taken a representative square-gibbed machine for the comparison with the V-gibbed machine? Evidently the same patterns were used for the column and ram of this special shaper as for the V-gibbed machine, and it is possible that the surrounding parts were weakened; other points of construction would make a difference, as it is clear that it is not fair to arbitrarily change the construction of a tool at any such important point without changing the design of surrounding parts to suit.

To formulate a criticism on this article, we must take a concrete example: one with which we are familiar, our own standard 16-inch back-geared crank shaper. We inclose a diagram similar to those shown in the article in question, showing the cross-section of our ram bearing according to our present practice. It will be seen that these measurements are very much greater all around than the square-gibbed machine used, and all together amount to about 50 per cent. more surface; besides our bearing is longer in the column, and the ram is longer. As we say above, the metal surrounding this bearing would make a difference in the rigidity. The size of the clamps and how they are held to the column, and the material and fitting of the side gib must also be considered. In our shaper this last is a heavy cast-iron strip, each one planed to a tapping fit, and scraped in under power.

From the description of square-gibbed bearing in the article, we see that this bearing was not scraped in according to our practice. On a careful reading it will be clear that the top clamps could be drawn down against the ram, so as to affect the power required to pull the cut; we scrape these top clamps to the ram just as carefully as we do the side gib, but this was not done in the shaper in question. It will easily be seen that a poor bearing here would be directly opposed to accuracy, and as the article states, if it were drawn down on the accuracy tests, it would have taken too much power to drive. In our shaper these clamps are drawn solid against the column in such a way that the ram is a close running fit to the clamps, just as it is to the side gib; in fact, the whole bearing is scraped to a true box fit under power, the side gib being planed to a tapping fit, and scraped to an iron-to-iron bearing. Being cast iron to cast iron, with proper oiling, it will soon form a glaze similar to case-hardening, and with the good workmanship and wide bearings there would be very little wear and small occasion for setting up. This can easily be done by any mechanic, from the side of the ramway, while the top of the column is slightly relieved in the center to allow for adjustment of the top clamps by scraping or filing. This side gib is similar in action to a bushing in a circular bearing, and provides for an easy realinement of the ram, by any mechanic in any shop that affords a planer.

In considering the ram bearing of a shaper, the peculiar thrust must be taken into consideration. It is evident that on a roughing cut the thrust is principally out with a strong upward tendency, and as the table is usually fed, will be toward the operator in front and to the opposite



RAM BEARING OF THE QUEEN CITY SHAPER

side to the rear. The pressure on the V-gib would be nearly at right angles to the flat surface, with a strong tendency to draw down into the sharp angle, surely a wedging effect that would take more power to drive. In the square type the pressure would be principally into the angle formed by the side gib and top clamp, an angle more like the V of a planer than any other. In our opinion any manufacturer who tries to say that the V under the ram of a shaper makes it like a planer bearing must be standing on his head. On finishing cuts the V-gibbed machine becomes an inverted V, the top being cut out by the ram, with the bearing on the sides of the two planes, surely wedging up again, with a tendency to lift much more than a properly made square gib.

We believe all the arguments that could be brought to bear would not convince some people, and one man has as much right to his belief as another. We believe that practical tests like the ones made are much more valuable; so we offer our shaper for comparison with any other, and only ask conditions such as will be fair to all concerned. If these tests can be arranged for we will agree to pay our share of the expenses of the trial.

If the above tests are made we will even put the burden of the proof on ourselves; we note the cuts, the article stating that "the machines were subjected to as heavy cuts as could be given without overloading," and also that on a cut under power tests, which we suppose were the heavy tests of 0.3125 × 0.035, the horsepower required was 3.18. We will agree to remove four times the cast iron without overloading, and not use more than double the horsepower required on the light cut as above. We will also agree that for every 0.01 of inaccuracy shown on the square-type machine we will not show more than 0.001. All we will ask, if these tests are made is, that there shall be a square deal for all, and that the results of the tests be given all the publicity possible, by giving them to the AMERICAN MACHINIST to be published in their first weekly issue of any month.

QUEEN CITY MACHINE TOOL COMPANY.
Cincinnati, Ohio.

Belt Feeds in England

With reference to your leading article on page 760, may we be permitted to thank you for your perhaps somewhat tardy recognition of the advantages of the belt-driven feed for milling machines? For many years we have manufactured a line of milling machines which have been continuously developed in the direction of increase in weight and in metal-removing power, and we have throughout retained the use of a belt for driving the feed in preference to a gear drive in spite of the prevailing fashion. We have always believed in our own policy and that it has not been altogether wrong is indicated by the results which are alluded to in your leading article.

In support of your argument for the belt-driven feed we give the following quotation from an article published in the *Engineer* of January 30, 1903:

"There can be no advantage in having a feed driven 'positively' providing that the alternative 'nonpositive' arrangement is sufficiently powerful for the heaviest work to be done.

"There has been a tendency of recent years to make the word 'positive' into a kind of fetish." In the majority of cases the adjective 'powerful' conveys a much better idea of what is desirable than the word 'positive' as applied to feeds, and at the same time allows the designer considerably more latitude and enables him to steer clear of dangerous breaking points. A great objection to all positive feeds is the danger of breakage should a jam take place, and this fact has been recognized by several prominent milling-machine makers, who provide a breaking piece or some

similar device to save the gears from a general catastrophe in case of a jam. This appears to be a tacit admission that the so-called 'positive' feed requires to be made 'nonpositive' in order to be safe, and is an argument against rather than for positive feeds."

We should be glad to think that the tendency in machine design in the future is to be along the lines of efficiency rather than of fashion, and we believe that no better work could be done by the AMERICAN MACHINIST than to impartially examine the symptoms of each mechanical epidemic at as early a stage of the disease as possible.

ALFRED HERBERT, LTD.,
Coventry, England. P. V. VERNON.

A Variable Speed Heat Consumer

I was very much pleased to read Mr. Osborne's article on a variable-speed invention on page 957, as it is just what has been bothering me for some time, although I had never thought of sending my views to the AMERICAN MACHINIST.

I was visiting a nearby shop one day when a friend of mine greeted me with the remark, "Hello, Bailey, I've got the greatest variable-speed invention on the market. I have placed quite a few of them in the shops on trial and would like to have you interest your people in this thing. Come up and have a look." Well, I had the look and witnessed about the slickest thing in variable-speed transmission that it has ever been my lot to see. He had it so variable that it would go from a crawl to a high speed and back again, and stop and start and, in fact, run at any speed, and all this with just the manipulation of one small button. I believe it could do a clog dance with the proper engineer at the throttle.

I was very much struck with this and my sanguine friend showed me the parts of one not yet assembled. It was just such a thing as Mr. Osborne described and is doubtless the one that he had in mind. The governing apparatus, controlled with one little button, was as nice a piece of mechanism as one would care to see, but when he showed me how he got the change of speed, with the consequent slipping, I asked him about heating. "Oh, it doesn't heat up; you can hold your hand on it at any time," was his answer. "The clutch surfaces were so large and heavy that the heat is conducted away and radiated as soon as it is developed." When I asked him about power lost in friction he tried to explain to me that there was none, that the governor was so sensitive that it would grab and let go instantaneously, with practically no friction. He may be right, but he has got me guessing. Perhaps he uses some of Mr. Grant's new form gear teeth on his friction surfaces, but if so they are very minute and invisible without better eyesight than mine.

My own opinion is that it is a cross between an absorption and a transmission dynamometer and would find a large field for the first kind of work, especially in the gas-engine testing business.

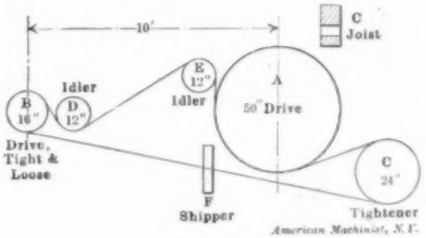
I have since seen several installed in other shops, but none of them seems to have a great variation of speed. It strikes me that perhaps my friend does not care to put a machine with a large amount of variation out of his own shop. The loss of power through friction would, of course, vary with the amount of slip, and the greater the variation in speed in one machine the greater the slip. With too much lost power there might be a call for help from the engine room.

Now I may be way off in my calculations, but if so, I would like to have some friend of this variable-speed heating and ventilating plant set me right through your columns.

Chicago, Ill. B. J.

Another Belt Drive

The ingenious arrangement of a belt drive, shown on page 751, by Mr. Anthony, has suggested another which uses



ANOTHER BELT DRIVE

one less pulley and avoids cutting the joist. The large drive pulley being 50 inches and the driven 16 inches, it requires less than one-third the larger circumference to secure equal belt contact.

Lynn, Mass. A. A. BALL, JR.

Method of Straightening Machine Tables

I was interested in Dixie's description, on page 840, of Mr. Armstrong's method of straightening the small planer or milling-machine table, and wish to suggest one better way: Make the table so it won't get bent by peening.

Assume the table to be for a planer or milling machine. Make one bolt slot along the middle, as usual, for locating the centers or splining shafts, and put in crossways all the slots that can be gotten in, leaving the iron between the slots only about as wide as the slots themselves.

There will be at least four advantages in this. The table will stay straight; bolts can be put in far more conveniently; work will not need to be clamped so tightly to prevent slipping, and the chips can be more easily cleaned out of the slots.

We have had a number of these cases of warped beds, as likely has every shop, and have cured it in our large milling machine by putting on a supplemental table, blocking it up on washers (about one-quarter the way from each end), and for convenience have made the slots as above described. We were fortunate in having a traversing machine to dress out the slots. An Adams milling head on a planer, where they have no traversing machine, will do the job to the queen's taste.

Syracuse, N. Y. JOHN E. SWEET.

Transferring Holes

The article by Ralph W. Davis on page 751 interests me as I have used the device shown. In Fig. 1 I show an improvement. *A* is a rod, preferably of cold-rolled steel as it requires no finishing. A small hole is drilled off center in the end. The hole need not be more than 1/16 of an inch in diameter. A small hardened tool-steel pin is driven in the hole as shown as *B* in Fig. 1. When in the shop I had a series of these tools made from ¼ up to about 2 inches diameter and found them very handy. However, where it can be used I prefer the tool shown in Fig. 2. The body of this is also made of

FIG. 1

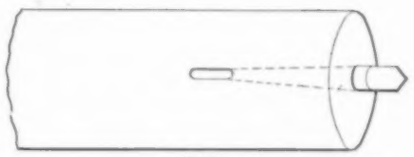


FIG. 2 *American Machinist, N.Y.*

A TRANSFERRING SCRIBER AND DRILL

cold rolled but the hole is drilled in the center of the end. This hole may be either tapered or cylindrical, to conform to the body of the small flat drill *B*, which is driven into the end. When making tools like Fig. 2, from ½ inch upward, I made the drill for the end ¼ inch in diameter so that it would interchange in the different bars. I find that there is less likelihood of error creeping in when using Fig. 2 than when using Fig. 1, even if the hole in the end is off center slightly the drilled hole will be concentric with the guide hole if the bar is a good fit.

New York. E. A. DIXIE.

Alloy Steels for Motor-car Construction*

Kinds of Steel to Use and Reasons Why. Hardening, Carbonizing, Forging and Testing the Metal. Table Showing Composition, Strength, etc.

BY JOHN A. MATTHEWS†

At the beginning of the twentieth century there was no automobile industry; today, before one decade has passed, we see a new industry of imposing magnitude. There are in the United States over 250 makers of automobiles, and this number does not include makers of commercial motor vehicles and trucks. In short, it refers to makers of cars primarily for pleasure purposes.

Upward of 100,000 employees are directly engaged in these factories, and not less than 4000 allied industries and works are more or less dependent upon the motor-car industry. Truly this is remarkable growth, and if, by reason of its years, this is still an "infant industry," all must admit that it looks like a thriving infant.

The exigencies of the demands of motor-car construction have proved a wonderful stimulus to the metallurgy of special steels. The heavy moral responsibility which rests upon both the maker and user of alloy steels and the tremendous duty expected of these materials of construction—lightness without sacrifice of toughness or strength—tend to make the requirements of the automobile trade most exacting.

Variableness of Nickel Steel

It is inconceivable to my mind how any firm can conscientiously put out a car and not know intimately the materials used in every essential part. Yet such is frequently the case—gears are bought from A solely because his price is lower than that of B and C, but the materials from which they are made are often unknown to the purchaser and rarely specified excepting perhaps in a general way.

For example, nickel steel is asked for. Now nickel steel is a delightfully variable and uncertain quantity as ordinarily made. To say that you use nickel steel is about as definite as to say you own an automobile—it may be a Packard limousine, or a farmer's high-wheel auto-buggy. Both run by their own power on four wheels, but there the resemblance ceases. There are of nickel steels—like pickles—at least 57 varieties, and the user should know what kind of nickel steel goes into his gears and who makes the steel as well as the gears.

Doctor Guillet, the distinguished French metallurgist, has previously pointed out that the constitution and mechanical properties of nickel steel depend essentially upon the sum of the carbon and nickel. From my own experience I should add to this sum the manganese. One hears continually in the trade nickel steel referred to solely by its percentage of nickel. Such expressions possess no real significance as a measure of quality or adaptability for various purposes. It is the skilful blending of the elements carbon, nickel and manganese that counts, and the successful accomplishment of this is a fine art.

The Making of Specifications

Almost as bad as not specifying at all is the tendency upon the part of many buyers to tell the maker how he ought to make his steel; to specify chemical analyses and physical tests which are a misfit, and, to quote Dr. C. B. Dudley, to make the wording of the specification "a place to show how much they know, as well as to display a mental attitude of favor or antagonism to any of the parties affected by it."

Without attempting any scientific classification of alloy steels, or enumerating all types that have been used at home and abroad, I will briefly describe the principal types used in the American trade.

Nickel Steel

Nickel steel is perhaps the most generally used of the alloy steels. Its merits are often obscured by irresponsible makers whose product lacks uniformity—we have even heard of the nickel itself being omitted. The analysis usually desired but not always attained is: Carbon, 0.20 to 0.25; nickel, 3.50; manganese, 0.60 to 0.90; sulphur and phosphorus, not over 0.04. With carbon and nickel as above stated manganese ought never to exceed the limits mentioned. A slightly lower carbon is sometimes used for case-hardening purposes, and a higher carbon is much used for crankshafts. With higher carbon we should prefer lower manganese. A small quantity of 5-per cent. nickel steel is used in about the same carbons.

Certain firms claim to sell crucible nickel steels in these compositions; personally, I have never known of a pound of such steel being made commercially, and the prevailing price of nickel steel is pretty substantial evidence that it has not been produced by the crucible process. It is usually made in the basic open-hearth furnace; with reasonable care, however, nickel steel can be made uniform, physically sound, and free cutting in this way.

It has remarkably good mechanical qualities when subjected to suitable heat treatment and is an excellent steel for case-hardening. In machining qualities it usually takes first place among the alloy steels.

When extraordinary care is used in its manufacture, and it is not made in too large heats or ingots, and when piping and segregating is avoided by confining the finished product to that produced from the bottom two-thirds of the ingot, we have an admirable product for many purposes.

In manufacturing such steel in the electric furnace, relatively small ingots only are made wherein segregation and piping are negligible.

No. of Tests.	Carbon, Per Cent.	Manganese, Per Cent.	Nickel, Per Cent.	Chromium, Per Cent.	Vanadium, Per Cent.	Elastic Limit in Tons.	Tensile Strength in Tons.	Elongation in 2 Inches.	Reduction in Area.	Heat Treatment.
4	0.21	0.86	3.48	....	....	68	112	13.7	45	1550 F. oil 600 F.
4	0.25	....	3.50	....	....	85	109	13.4	....	1550 F. oil 600 F.
2	0.27	....	3.50	....	....	86	110	13.3	51	1550 F. oil 600 F.
30	0.18–0.28	0.60–0.90	3.5	....	....	68	103	12.9	54	1550 F. oil 600 F.
11	0.18–0.28	0.60–0.90	3.5	....	....	84	116	12.4	48	1600 F. brine.
4	0.25	0.60–0.90	3.5	....	....	88	121	12.2	48	1600 F. brine
7	0.23	0.61	3.54	....	....	103	114	14.0	50.7	1550 F. water 212 F.
1	0.14	0.63	3.64	....	....	78	88	15.0	54.6	1500 F. water 212 F.
1	0.14	0.63	3.64	....	....	30	41	33.5	72.4	1400 F. oil 1200F.
4	0.35	0.45	3.39	....	....	77	84	15.5	55.5	1500 F. water 900 F.
4	0.35	0.45	3.39	....	....	130	137	10.0	36.3	1500 F. water 430 F.
3	0.25	0.86	3.45	....	....	31	45	31	60	Natural, as rolled.

TABLE 1.—NICKEL STEELS.

Chrome Vanadium Steel

Chrome vanadium steels in a profusion of types have of late attracted the profound attention of automobile engineers. J. Kent Smith has but recently discussed these products before this Institute, and his work in connection with these steels is deserving of the highest praise. As an illustration of the novelty of vanadium steel as a commercial commodity, I well recall being quoted $75 per pound for vanadium not many years ago.

*Abstract of an address delivered before the Franklin Institute, Philadelphia, Penn.

†General manager of the Holcomb Steel Company, Syracuse, N. Y.

The chrome-vanadium alloys are preferably made in the crucible or electric furnace, although the open-hearth process is also much used for the purpose. The open-hearth product, I believe, is somewhat uncertain, and while, for example, an open-hearth chrome-vanadium spring steel may be better than plain carbon-crucible spring, it is not to be compared with genuine crucible chrome-vanadium steel when properly melted. For excellent quality, this product constitutes the highest attainment of the steelmaker's art.

These alloys are, in general, made in a high-carbon type, suitable for oil-hardened gears and springs, and in several low-carbon types—such as a case-hardening type for gears and a type suitable for oil quenching followed by annealing for axles, shafts, and steering knuckles. By judicious blending of chromium and vanadium and adjustment of the manganese and carbon one can not only obtain all static properties that can be obtained from nickel, chrome nickel, or silico-manganese alloys, but in addition obtain dynamic or antifatigue qualities far in excess of those displayed by any other alloys.

In general, nickel-chrome steels possess excellent static qualities, but the difficulties in heat treatment, forging and machining lead one to prefer the other type of alloys previously mentioned. Equally good physical characteristics can be obtained more cheaply in first cost and in shop costs from nickel or chrome-vanadium alloys. We shall speak later of the relative merits of these steels for oil-hardened gears and springs.

Silico-manganese and silico-chrome in medium carbons have had considerable popularity abroad for springs and for gears. They, also, are made in low carbons. Their relatively low cost favors their use, but their feeble resistance to shock and sensitiveness to heat treatment limits their use. When handled with great care they give good results in works well equipped for obtaining accurate results in their heating treating operations.

Chrome steels in high carbons are much used for balls and ball races.

Tungsten Steels

Tungsten steels of special analysis are universally used for making magneto magnets. All statements and opinions to the contrary notwithstanding, the magnet steel now made at two works in this country is rarely equaled in quality and never equaled in uniformity by foreign products. If foreign magnetos are superior to domestic ones it is because of their mechanical construction and not because they possess, in general, better magnets. The writer feels very deeply upon this subject and has probably made the most exhaustive experiments ever made upon the manufacture and properties of permanent magnet steel.

No. of Tests.	Carbon, Per Cent.	Manganese, Per Cent.	Nickel, Per Cent.	Chromium, Per Cent.	Vanadium, Per Cent.	Elastic Limit in Tons.	Tensile Strength in Tons.	Elongation in 2 Inches.	Reduction in Area.	Heat Treatment.
1	0.34	0.17	3.88	....	....	29	43	27.3	54	Natural as rolled.
1	0.33	0.16	3.72	....	0.12	41	54	23.8	53	Natural as rolled.
1	0.33	0.16	3.40	....	0.24	49	66	17.8	40	Natural as rolled.
1	0.34	0.17	3.88	....	....	37	51	16.5	51	1500 F. oil 1150 F.
1	0.33	0.16	3.72	....	0.12	51	59	24.0	61	1500 F. oil 1150 F.
1	0.33	0.16	3.40	....	0.24	59	62	21.0	61	1500 F. oil 1150 F.
1	0.34	0.17	3.88	....	....	59	66	15.5	55	1500 F. oil 600 F.
1	0.33	0.16	3.72	....	0.12	70	76	14.5	56	1500 F. oil 600 F.
1	0.33	0.16	3.40	....	0.24	82	85	15.0	55	1500 F. oil 600 F.
1	0.24	0.72	3.33	....	0.12	38	49	27.0	64	Natural as rolled.
1	0.24	0.72	3.33	....	0.12	71	100	11.6	36	1600 F. oil.
1	0.24	0.72	3.33	....	0.12	92	117	14.5	52	1600 F. water.
1	0.24	0.72	3.33	....	0.12	91	116	15.2	57	1600 F. brine 400 F.

TABLE 2.—NICKEL-VANADIUM STEELS.

From a wide experience with all types of alloys, it is my opinion that where a better material than the best nickel steel is needed, and especially when dynamic excellence is sought, the appropriate types of vanadium-chrome steels may be unreservedly commended. They forge well and machine more readily than chrome nickel steels of corresponding carbon percentages.

Other Chromium Steels

Chrome-nickel steels are usually made in a high- and a low-carbon type. The former is used for oil-hardened gears and springs and the latter for general structural purposes, such as axles, shafts, forged parts, and for case-hardened gears. The high-carbon type carries about ½ per cent. of carbon and the low-carbon alloy ¼ per cent.; the nickel as supplied by various makers varies from 2 to 3½ per cent., while chromium from 1 to 1½ per cent. is usual. A nickel-chrome-tungsten steel is sometimes used for springs.

Testing Apparatus

The best alloys are none too good for automobile construction; when one has secured the best the market affords, the first step only has been taken to produce good parts. Next come the forging and machining and the heat treatment, for better or worse. It is money wasted to buy good alloys unless one is willing to study them sufficiently to know how to treat them and then to supply adequate facilities for so doing.

It is not to be expected that small users will install complete testing laboratories, but a few dollars invested in having occasional tests made will be well spent. There are, however, many large concerns that could and should spend, say $5000, for which it is believed the whole or a large part of the following equipment could be obtained: The ordinary tensile machine, a microscope, electrical or gas furnaces capable of fine regulation, a good pyrometer, preferably recording. The tensile machine can also be used for making Brinnell hardness tests, spring-deflection tests, etc.

In addition to these some form of drop-testing machine, such as the Fremont, will be found valuable; a vibratory or repetitive impact test is nowadays considered a necessity, while cold bending and torsion apparatus is useful.

This equipment will be of small use, unless a thoroughly good man is put in charge—a careful, conscientious man of sound judgment. This man should direct the heating operations in the factory; he should construct furnaces which heat uniformly, and he should exercise eternal vigilance in keeping the pyrometer installations up to par.

Pyrometers

The pyrometer is too often supposed to take care of itself. Too frequently it is never questioned, never calibrated. The best pyrometer of the thermocouple type should be looked over at stated intervals, especially if in constant use. Protecting tubes should be frequently examined and renewed, and electrical contacts looked over. Occasionally check up the millivoltmeter. Unfortunately there are many pyrometers of the thermocouple type on the market which cannot be watched too closely.

If you are going to have pyrometers, by all means see that you have good ones, and then see that they are systematically tested. Many people buy high-priced alloy steels and get no better results from them than could be had from a carbon steel properly handled. If you cannot afford a good pyrometer stick to the trained eye of a skilled man; and if you have a good pyrometer employ a skilled man anyway, and consider the pyrometer as an aid. With it you can at least give orders in temperatures rather than in heat colors, and the laboratory and works can meet on an intelligent basis.

Benefits of Heat Treatment

Heat-treatment operations depend upon a solid scientific basis. By this we do not mean that steel essentially of inferior quality should be made to pass muster by heat treatment. On the other hand, however, it might be said that alloy steel in its so-called natural state, as it comes from the rolls, hammer or drop forge, is almost unfit for automobile construction.

Steel which depends upon alloys for a high elastic limit in its natural condition will have much less elongation than the same steel oil-tempered and annealed. For example, a chrome steel gave in its rolled condition 158,000 pounds elastic limit and 5 per cent. elongation, with 9.4 per cent. reduction of area. The same steel oil-tempered and annealed gave 153,000 pounds elastic limit, 14 per cent. elongation, and 52 per cent. reduction of area.

In other words, the material was transformed from brittle to tough, from treacherous to safe, without materially affecting its elastic limit. A nickel steel similarly treated had its elastic limit raised 20 per cent. with the reduction of area improved and its elongation unchanged.

Case-hardened vs. Oil-hardened Gears

In the automobile trade there have existed two schools, so to speek, one believing in the case-hardened type of gear and the other in the oil-hardened type. As previously mentioned, the chrome-vanadium, chrome-nickel and silico-manganese alloys are made in both high and low carbons. The former contain about 0.45 to 0.60 per cent. carbon and enough other hardening elements so that by merely quenching in oil from a bright red heat a surface-hardening is produced sufficient for ordinary wearing purposes while the hardness does not penetrate deeply into the gear, but leaves a core that is tough and strong.

The low-carbon alloys, with about 0.20 per cent. carbon, require to be carbonized or case-hardened in order to produce sufficient surface-hardening for wearing purposes after hardening. My word on the merits of gears made by these two methods will hardly be accepted as final, as I am not an authority upon gears. Several years of observation and contact with the trade, however, leads me to prefer the case-hardened gear.

The result of direct tests upon thousands of gears of both types leads me to the following conclusions: (1) The static strength of a case-hardened gear is equal to that of an oil-hardened gear, assuming in both cases that steel of the same class and appropriate analysis has been used, and that the respective heat treatments have been equally well and properly conducted. (2) Direct experiments proved that the case-hardened gear resists shock better than the oil-hardened. (3) As regards resistance to wear the same type is incomparably better, although perhaps not as silent in action.

One of the leading makers of gears has proved this to his own satisfaction of late by an arrangement of shafts and gears whereby energy is transmitted through two case-hardened gears, in mesh with each other, to two oil-hardened gears. The gears are of the same size. The conditions of the test were severe. Five sets of the oil-hardened gears have already been worn out while the original case-hardened gears are still in service and show the tool marks.

Upon the part of many there is strong objection to case-hardening. In nine cases out of ten this is doubtless due to the fact that the case-hardening operation has not been reduced to a science. The depth of case, the relation of case to core, the time and temperature to produce certain results and the exact control of these conditions, together with an accurate knowledge of the material to be treated, are the factors that enter into successful case-hardening practice. Further points in favor of this method are easier machining of the blanks, and at least equal static and dynamic properties with less chance of injury in hardening.

Cut and Forged Gear Blanks

While considering gears, we may as well dip in a little deeper and consider the relative merits of gears cut from bars and from drop-forged blanks. Parts like spur gears, bevel pinions, and many shafts may either be drop-forged or cut from bars in automatic machines. Contrary to general opinion many parts can be machined out of bars as cheaply as they can be from forgings. Moreover, I am firmly of the opinion that no steel is improved physically by drop forging, some steels, of course, being less susceptible to injury than others.

In good steel-mill practice great attention is paid to proper finishing heats, and steel is brought gradually to size. In drop-forging work, in order to give sufficient plasticity to assume various forms in dies, it must be heated very hot. It is then frequently formed with the fewest possible blows.

An investigation of drop-forged and bar-cut gears, the former being the product of one of the foremost dropforging companies, showed that under static test the bar-cut gears, as the average of many tests, were fully 25 per cent. stronger, and their resistance to shock test was also much better, but the difference cannot be exactly stated in percentage.

The fact that the static test did not show more than 25 per cent. average superiority for the cut gear was a surprise to me and speaks well for the forging concern in question. In many cases, I fear a larger difference would be found. It is just such points in the construction of various makes of cars of the same general design that would be of great benefit to the would-be purchaser could he but know them.

Carbonizing a Science

To show that case-hardening is a science, let me quote from Doctor Guillet once more. In reference to the proper procedure in case-hardening he says: "As is well known, the operation of case-hardening consists of placing a steel in some medium capable of imparting carbon to it, at a suitable temperature; after a sufficient interval a steel is obtained, the interior of which possesses the same percentage of carbon as before case-hardening, but the exterior of which is much higher (0.80 to 1 per cent.)

On quenching such a steel an extremely high degree of mineralogical hardness is obtained on the surface, while the center of the piece is non-brittle, that is, if the operation has been properly carried out. One generally uses steels containing 0.10 to 0.25 per cent. of carbon for case-hardening.

In order to avoid all brittleness in the interior and exterior of the piece, and, at the same time, to obtain a high degree of superficial hardness and a very regular degree of carburization (in carbon steels) it is necessary:

1. "To use a steel containing less than 0.12 per cent. of carbon, and with a low percentage of manganese (less than 0.30 per cent.) and

2. "To case-harden with a chemically definite material such as a mixture of 60 parts charcoal and 40 parts of barium car-

No. of Tests.	Carbon, Per Cent.	Manganese, Per Cent.	Nickel, Per Cent.	Chromium, Per Cent.	Vanadium, Per Cent.	Elastic Limit in Tons.	Tensile Strength in Tons.	Elongation in 2 Inches.	Reduction in Area.	Heat Treatment.
3	0.26	0.39	....	0.78	0.17	44	68	20	64	Natural as rolled.
1	0.26	0.39	....	0.78	0.17	103	139	3	8.2	1570 F. oil 400 F.
3	0.27	0.50	....	1.00	0.17	33	45	28	62	Annealed 1475 F.
1	0.27	0.50	....	1.00	0.17	52	63	21	56	Oil tempered and drawn to various degrees.
1	0.27	0.50	....	1.00	0.17	62	65	17	62	
1	0.27	0.50	....	1.00	0.17	70	74	17	57	
1	0.27	0.50	....	1.00	0.17	100	106	12	51	
1	0.27	0.50	....	1.00	0.17	112	116	11	39	
1	0.40	0.77	....	1.22	0.19	34	50	26	62	Annealed.
1	0.40	0.77	....	1.22	0.19	98	104	10	36	1650 F. oil 840 F.
1	0.30	0.50	....	1.00	0.16	71	76	16	56	1650 F. oil 1025 F.
3	0.38	0.73	....	1.19	0.18	41	65	22	67	Natural as rolled.
1	0.38	0.73	....	1.19	0.18	110	144	10.8	47	1660 F. oil 600 F.
1	0.38	0.73	....	1.19	0.18	64	113	12.9	53	1660 F. oil 850 F.
1	0.33	0.54	....	1.24	0.20	64	71	15.5	56	1500 F. oil 1125 F.
1	0.33	0.54	....	1.24	0.20	95	104	11.0	38	1600 F. water 600 F.
5	0.45	0.58	....	2.37	0.30	88	94	13.2	46	1600 F. oil 1125 F.
4	0.45	0.58	....	2.37	0.30	138	146	6.0	16	1600 F. oil 430 F.
1	0.36	0.21	....	2.78	0.24	60	104	4.1	88	Natural as rolled.
1	0.36	0.21	....	2.78	0.24	65	72	20	56	1500 F. oil 1150 F.
1	0.36	0.21	....	2.78	0.24	98	104	13	45	1500 F. oil 600 F.

TABLE 3.—CHROME-VANADIUM STEELS.

bonate at a temperature between 1550 and 1900 degrees Fahrenheit—the higher the temperature the more rapid the case-hardening—and allow it, after the operation, to cool down just below the transformation point (about 1100 degrees Fahrenheit).

3. "To reheat the piece and quench it at 1650 degrees Fahrenheit (just above the transformation point of the center), this operation having the effect of rendering the center fibrous."

This operation has the effect of toughening the center, but the outside will be coarse-grained and brittle. The next operation, acording to Guillet is

4. "To quench for a second time at 1475 degres Fahrenheit (above the transformation point of the exterior), to render the skin non-brittle.

Carbonizing Nickel Steel

"In any case, the methods by which it is possible to obtain, with low-carbon steel, case-hardened pieces which shall not be brittle, are exceedingly delicate."

How different this is from the operation one too often sees, where the pieces are dumped directly from the case-hardening boxes into water. However, if one uses a good grade of nickel steel, low in carbon, and case-hardens at appropriate temperatures, and then takes the precaution to cool off in the boxes before heating for quenching, and then hardens at about 1475 degrees Fahrenheit, the results will be fully equal or better than can be obtained by the most careful handling and double quenching of carbon steels. The saving in cost of the operation can be applied toward the greater cost of nickel as compared with ordinary case-hardening steel.

Better still, however, if nickel steel is used, is to give it a double quenching, too, then one obtains a really admirable product of extraordinary toughness and remarkable wearing qualities. An ideal way of making nickel-steel gear consists in first annealing the blank, then rough-machining, approximately, to size, then giving a light reannealing before taking the last finishing cut. Then pack in suitable mixture and carbonize to a depth of 1/64 to 1/32 of an inch, according to requirements, at a temperature of about 1625 to 1650 degrees Fahrenheit. Cool in the pots, heat to about 1500 degrees Fahrenheit and quench in a hot brine or calcium chloride solution. This will put the core into excellent physical condition. Finally, reheat to 1375 to 1400 degrees Fahrenheit and quench in oil. This last operation will refine the grain of the case and harden it with best results. The temper need not be drawn.

It will be noticed that the temperatures for treating nickel steels are considerably lower than those advocated by Guillet for carbon steels. If methods like these are followed it is not likely that a very great difference would be noted between bar-cut gears and gears cut from drop-forged blanks. In the case of medium carbon gears not to be case-hardened but oil-hardened only, one would probably find a greater difference and in this case we have no opportunity to restore the overheated forged blank by scientific heat-treatment.

This, in addition to the greater chance of overheating and the greater difficulty of machining, also favors the use of case-hardened gears, assuming, of course, the case-hardening is to be skillfully done.

No. of Tests.	Carbon, Per Cent.	Manganese, Per Cent.	Nickel, Per Cent.	Chromium, Per Cent.	Vanadium, Per Cent.	Elastic Limit in Tons.	Tensile Strength in Tons.	Elongation in 2 Inches.	Reduction in Area.	Heat Treatment.
1	0.37	....	2.9	1.04	....	60	78	18.5	61	1475 F. oil 1200 F.
4	0.37	....	2.9	1.04	....	77	84	16.0	56	1500 F. water 1100 F.
1	0.45	....	2.0	1.00	....	70	90	8.0	20	Oil-temp. and annld.
1	0.25	....	2.0	1.00	....	50	65	12.0	30	Oil-temp. and annld.
2	0.25	....	3.0	1.50	....	57	64	15.0	65	Annealed.
1	0.25	....	3.0	1.50	....	110	116	6.0	40	Hardened—oil.
1	0.50	....	2.0	1.00	....	33	46	27.0	64	Natural as rolled.
3	0.50	....	2.0	1.00	....	72	134	6.0	23	Tempered.
1	0.30	....	2.0	1.00	....	35	53	18.0	45	Natural as rolled.
1	0.30	....	2.0	1.00	....	68	98	9.0	37	Tempered.
1	0.30	....	2.0	1.00	....	45	55	25.0	55	Oil temp. and annld.
1	0.40	0.18	2.1	0.80	....	60	76	12.8	37	Natural as rolled.
1	0.40	0.18	2.1	0.80	....	58	66	17.5	40	1500 F. oil 1150 F.
1	0.40	0.18	2.1	0.80	....	106	118	10.0	34	1500 F. oil 600 F.
1	0.40	0.18	2.1	0.80	....	70	79	15.5	48	Annealed 1150 F.

TABLE 4.—CHROME-NICKEL STEELS.

Springs Used

There are in general two kinds of springs used in automobiles, coil and flat springs. The latter may be full, three-quarter, or half elliptic. From observation and general report it appears that the general maker of springs has not kept pace with the improvements in spring-steel and with the increased severity of the duty expected of springs. With many of them to suggest a change of method is like preaching heresy in a theological school.

The new steels cannot be handled just like the old ones and still obtain from them the maximum development of their powers. However, the new steels, being in general lower in carbon, will stand much abuse in heat-treatment and still produce springs of a quality undreamed of a decade ago. But how foolish it is to pay four or five times the cost of regular spring-steel and then not adopt methods to develop its maximum excellence even to an increased endurance of a hundred fold over plain carbon spring steel!

While as a class spring-makers may have been driven to the use of alloy steels, they have not as a class been forced to handle them scientifically. I am happy to say there are a few exceptions to this and I hope their number will increase. The old practice of forming and hardening springs with a single heating cannot be persisted in if maximum quality and service are to be secured.

Testing and Tempering Springs

Satisfactory tests on flat springs are somewhat difficult to make but in coiled springs quality can be easily shown and the relative merit of different steels demonstrated. The most satisfactory test is to operate the springs—open and close—by some sort of repetitive impact method until destroyed.

In order to produce results in a reasonable length of time the duty must be severe and the rate of alternations of stress rapid. The number of alternations of stress to produce fracture gives a measure of its vitality, so to speak. Average results of a great many tests made in this way of crucible carbon springs, chrome nickel, silico-manganese and genuine crucible chrome-vanadium springs proves the extraordinary quality of the last-named product and the antifatigue qualities imparted by vanadium.

The average figures for alternations were as follows: crucible carbon spring, 125,000; chrome-nickel and silico-manganese, each 200,000; crucible chrome-vanadium, 5,000,000, and still unbroken. This, then, is the panacea for all valve, clutch, brake and flat spring troubles.

The engineer of a company which makes a very heavy car and uses a semi-elliptic spring told me recently that they had not had a leaf break or a spring sag since adopting crucible chrome-vanadium springs made by an up-to-date spring-maker. Prior to this time they were in trouble all the time.

The tempering of this steel is quite simple. The springs should be heated to from 1675 to 1700 degrees Fahrenheit and quenched in oil. The temper is then drawn according to the nature of the spring and the duty expected. The drawing range is very wide, namely, from 600 degrees to nearly 1000 degrees Fahrenheit. In the line of spring-steel this product has my profound admiration.

Notes on the Tables

In presenting the four tables showing typical analyses, treatments and tensile tests of nickel, nickel-vanadium, chrome-nickel, and chrome-vanadium steels, we have drawn upon many sources of information, as, for example, the data published by the American Vanadium Company, experimental data upon tests made

by myself, and commercial tests made upon the steels of many makers.

The temperatures when given are approximately correct. In giving analyses only the essential elements have been given. We have expressed the elastic limits and tensile strength in net tons per square inch, and the elongations are as measured upon a two-inch test-specimen one-half inch in diameter.

These tables are given to illustrate the tremendous possibilities of careful heat-treatments, and in some instances they illustrate the danger of applying wrong treatments. The effect of variable carbon contents in alloys of the same type is illustrated, and varying qualities that may be obtained from the same alloy by different treatments may be observed.

One point I must mention in connection with these tests is, that in designing parts one must be very cautious not to be misled by the remarkable tests yielded when a standard test piece is treated and to use these figures as a guide to the physical qualities likely to result when a much larger mass of metal is treated. Because a half-inch test piece oil tempered and annealed gives an elastic limit of 75 tons per square inch, it does not follow that an inch-and-a-half-diameter bar similarly treated will yield the same results. The hardening action in quenching does not penetrate very deeply in a large bar, while in a small one it may penetrate to the center.

The piece treated in the form of a test piece gave me 42.5 tons elastic limit, 58 tons tensile, 21.5 per cent. elongation, and 58 per cent. reduction.

The other piece was over 4 tons lower in elastic limit; over 3 tons lower in tensile, and 2.2 per cent. and 3.6 per cent. higher in elongation and reduction respectively.

This shows that while it may be quite possible to obtain an elastic limit of 100 tons in a thin spring, one would not have the same elastic by the same treatment had the same steel been made into a massive gear.

Many of the figures given in the tables are the averages of several tests made upon materials of the same general kind, and in the first column of the tables is given the number of tests, either average or single, upon which the figures are based.

In the column marked "heat treatment" is given the temperature to which the steel has been heated, followed by the liquid in which it was quenched, and then by the temperature to which it was reheated to draw the temper or anneal. This will make clear such terms as 1600 degrees Fahrenheit—oil—600 degrees Fahrenheit, etc.

Depth of Hardness

I once made a quantitative experiment upon this point, using a 0.43 carbon steel, containing vanadium. The steel was in the form of an inch-round rolled bar. In one case I oil tempered a full inch section of the bar at 1600 degrees Fahrenheit and annealed it at 1030 degrees Fahrenheit, and from this machined up a test piece. In the other case, I made the test piece from the inch-round bar, and having reduced it to a half-inch diameter test piece, subjected it to the same treatment as I had applied to the full-sized bar.

A rather remarkable performance in watch manufacture is noted by a contemporary. The watch was made in Switzerland and is said to possess a thickness of 0.12 inch only, and what makes the achievement more extraordinary is that the watch is reported to keep correct time within five seconds a day.

From a report of comparative tests made by an American trunk line on the new ferro-titanium steel rails and those of the bessemer type it is noted that the wear on the former showed 1.45 pounds per yard, as against 4.18 pounds per yard on the latter, which is nearly 300 per cent. in favor of the new alloy steel.

A Convenient Drawing Board Lamp

By J. Fullmer Schott*

Realizing the advantages of a medium-power light concentrated over the work as compared with a high-power light near the ceiling, the lamp shown in the accompanying engravings was devised for the drafting room of the Link-Belt Company at Philadelphia.

A square steel bar is supported above the upper edge of the board by small brass brackets and carries a slide fitted with a universal joint into which the pipe arm is screwed. The wires pass through the upper half of the universal joint and the pipe arm into the lamp socket. The light is furnished by a 10-candlepower incandescent lamp, which is covered with an aluminum parabola shade.

The steel bar being raised above the board, permits the scales of the drafting machine, or, if this machine is not used, the triangles, to extend beyond the board, as shown in Fig. 1. By means of the slide the lamp arm can be set in any position across the board, the weight of the arm, lamp and shade locking it in position on the square bar. The universal joint on the slide allows the lamp to swing in an arc of a circle horizontally and vertically. The lamp can thus be brought to any position over the board and at such an elevation as will prevent the light from shining in the draftsman's face. The lamp can be made to light up the reference tracings at either end of the board by bringing the slide to the end of the square bar and swinging the arm out over them.

Fig. 1 shows the drafting machine near the upper edge of the board with the lamp so placed that the parallel rays from the parabola shade will fall directly on the working edges of the scales.

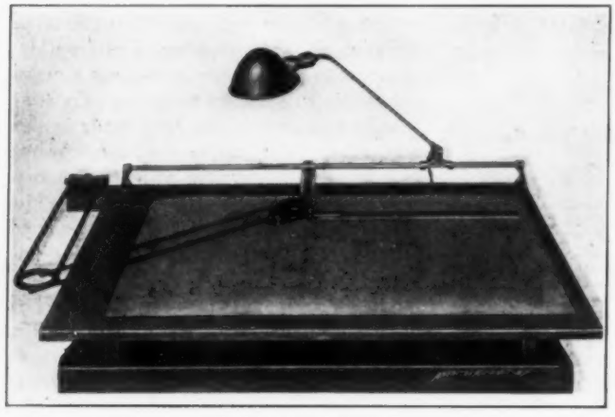


FIG. 1

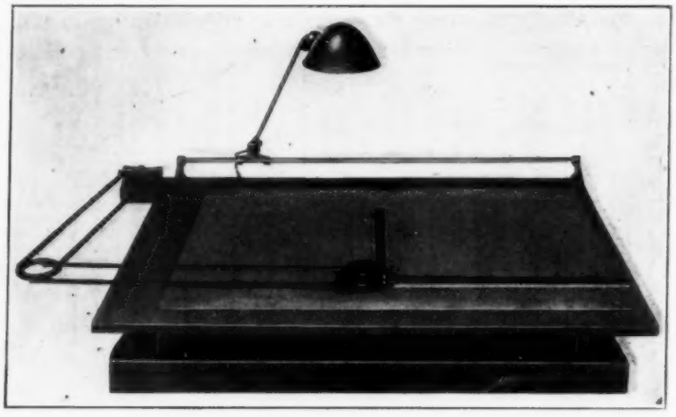


FIG. 2

A CONVENIENT DRAWING-BOARD LAMP

*Chief draftsman, Link-Belt Company.

Fig. 2 shows the lamp in position to throw a light over the whole board, to allow for a general sizing up of the drawing by the draftsman, or a criticism by the man in charge.

Fig. 3 shows a portion of the Link-Belt Company's drafting room equipped with 50 of these lamps. There is an entire absence of overhead wiring. This results from running the main wires under the floor and bringing the individual wires to the fixtures through floor receptacles, allowing enough slackness in the wire to permit travel of the slide.

These lamps have been in use for six months and show the following advantages over the overhead lamps:

1. All the men are well pleased with them.

2. A saving of 5 horsepower with all of the lamps burning; the saving, however, is much greater when a few men are working at night, or on dull days, as it is then necessary to light only the individual lamps for the draftsmen at work or requiring them, whereas with overhead lamps it is necessary to light the whole room, or a greater part of it.

3. Absence of shadows and flickering.

4. A restful semi-darkness above the lamps for the draftsman to relieve his eyes.

5. A mild, steady light concentrated at that part of the drawing on which the man is working.

6. An excellent light for tracing both drawings and blueprints.

7. No light burning after closing time.

8. Not necessary to run direct-current generators at night, as alternating current from the city wires is available.

9. There is no glare or annoying rays to bother the men, as is the case with suspended lamps or ceiling clusters.

10. Low first cost and maintenance charges.

Trade Opportunities in Ecuador, Uruguay and Paraguay

By M. de Moreira

In spite of the general crisis which happened last year, it is noteworthy that the foreign commerce of Ecuador for that year showed an increase of nearly one million and a half dollars. This is the more remarkable from the fact that the increase was almost entirely on the side of imports, thus showing improvement in the purchasing power of the country.

The total value of Ecuador's foreign commerce during the year in reference is given as $21,643,200, divided between exports, $11,795,213 and imports, $9,849,987. The figures given for the imports, though apparently small, show, nevertheless, an increase over the preceding year of $1,344,187. The United States stands second in imports and bids fair to give England a good fight for the first place.

A few months ago the government of Ecuador approved the contract made with the Guayaquil & Quito Railway Company for the building of a railway from the city of Guayaquil to Quito. This railway, though now completed, has still various branches under construction and manufacturers have a fair chance to sell their machinery for the building of these small roads. The ramifications, either from Guayaquil or from Quito, are to be built, according to contract, within the next two years.

Another work which ought to interest our manufacturers is the installation of an electric tramway service in Quito and suburbs. The Quito Electric Light and Power Company has charge of the contract and the concession it has obtained, according to reports, is for 75 years. This ought to appeal to small manufacturers who, if they went at it in the proper fashion, would find an outlet for their goods in Ecuador, without the fear of coming into competition with large firms. Everything pertaining to electric plant is of great interest to the

FIG. 3. DRAFTING ROOM OF LINK-BELT COMPANY EQUIPPED WITH CONVENIENT DRAWING-BOARD LAMPS

Ecuadorians who, living in a very tropical climate, and having within their boundaries plenty of water power, have realized the advantages given by electricity and also its cheapness compared with steam or gas.

There is, of course, very little manufacturing. Two foundries, two ice plants, seven sugar refineries, 20 mills of different kinds and a small shoe factory comprise the whole of the actual manufacturing done in Ecuador. Manufacturers of machinery used in the erection of steel buildings will find a growing market there as, presumably, the Ecuadorians find that steel construction should be used there and the government is not only encouraging this idea but for the new market building which is to be erected in Guayaquil has decided to give a good example and use a steel frame.

Manufacturers should not look upon Ecuador as too small a country to do any trade. Ecuador has little trade in machinery, it is true, but is making the most of its possibilities and is improving every year, and manufacturers who could devote some time to learn about the country and its advantages will, no doubt, learn that they probably manufacture machinery which could be used for this or that purpose and which, if properly shown to the natives, they would not hesitate to try and thus develop the wealth of their own country.

Uruguay

Uruguay is naturally a small center for business due to its being overshadowed by the great South American republic, Argentina and the peculiar location of its capital in relation of the Argentine metropolis. Nevertheless, Uruguay is trying hard to imitate its neighbor in gridironing its territory with railways. The latest move in that direction is the concession given to the Uruguay East Coast Railway Company to construct, equip and work a line from the Sierra to Maldonado and to Rocha and also to purchase from the government the existing line of railway from Olmos Junction to La Sierra. The purchase of all the material for construction and equipment is specified in this contract and American manufacturers will have once more an opportunity to compete with their English rivals. Another railway, on which the work of construction will soon begin, will extend from the Tres Arboles to Piedra Sola and will be carried out by the Midland Railway.

Railway lines in operation in Uruguay aggregate 11,447 miles, of which 780 miles have state guaranties. The great disadvantage that American manufacturers will encounter is that nearly all the railways belong to English companies, though in some instances the purchasing agent is a native and will favor the purchase of American-made machinery, etc. Several important engineering works are either in construction or will soon be begun, as these railroads require three tunnels and 35 bridges.

Another opportunity for our manufacturers lies in the port work. Until now ships have been obliged to anchor very far out and the transportation of passengers and merchandise is done under great difficulties as the sea is very rough and freight has very often been damaged for lack of facilities for handling it. The construction of a breakwater which is now under progress will somewhat diminish this, but other works are needed before the facilities for transhipment can be properly provided. The government has decided to dredge the channel to a depth of seven meters and also to construct moles, etc. Again, this is an opportunity for manufacturers of machinery used in port and dock work, and American manufacturers doing business in Buenos Aires have only to consider that it takes but a night to go by boat from that city to Montevideo and also that the financial conditions of Uruguay are excellent.

Paraguay

The foreign commerce of Paraguay, according to the latest information is valued at $11,097,382. This is an increase of more than one million of dollars over last year's total. However, of ten countries which have export trade with Paraguay, the United States stands ninth in rank. Of course, that country, being inland, makes it more difficult to have business relation with far-distant manufacturing countries, nevertheless, we are not farther away than Great Britain or Germany and it seems that if they can do a fairly good business with that republic, so could we.

In order to facilitate commercial transactions the government of Paraguay has decided to dredge the rivers of the country. The government will have, therefore, to purchase dredging apparatus and materials and supplies necessary for that work, as, so far, machinery of that kind has never been used there. Little railroading is done in this tiny republic, but electric street cars and, in general, anything pertaining to light and power ought to be well received there, as water power is certainly not lacking.

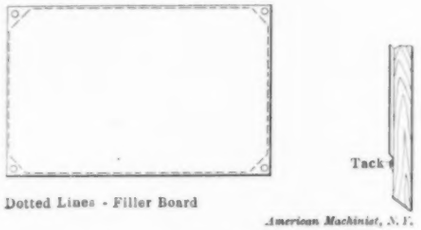
There is, however, an industry which, through ignorance, has not been approached in Paraguay and that is meat packing. A manufacturer of machinery for packing plants could easily establish there a complete packing and canning establishment. Nearly two-thirds of the Paraguayan export trade is in hides, and the cattle killing is of the most primitive manner, resulting in a waste which, if used, would bring to the owner of a packing plant a fortune within a very short time. Having traveled all over that country I find that the two opportunities, electric power and a packing plant, are for the present, at least the only things which could interest American manufacturers, but I am also positive that they are both sources of great wealth to be attained in a very short time.

Method for Fastening and Backing Drawing Paper, etc.

By H. R. Ash

For fastening and backing small sheets of drawing and tracing paper and tracing cloth to the drawing board I use a scheme which has several advantages. For each size of sheet used I have a piece of filler board, which is the kind of paper used for covers for cheap memorandum books and is about 1/32 inch thick, yellow or brown in color with a mottled surface. I simply clip the corners, as shown in the sketch and use four ordinary thumb tacks, on the corners for the small size sheets and for the double size sheet several tacks along all four edges.

Advantages: The paper or cloth is drawn over the edges of the filler board, which tightens it. The tops of the thumb tacks are slightly below the surface of the



METHOD OF BACKING DRAWING PAPER

drawing paper, or tracing cloth, or paper and, therefore, out of the way of the T-square, triangles and other instruments. The filler board makes an excellent backing for pencil work and erasures for pencil and ink and for the center points of the compasses and dividers and for the needle points used for stepping off measurements, as the filler board is hard, smooth and tough. It will stand much hard usage and is especially advantageous when working a poor grade of drawing paper, which has no body of its own. As a covering for a drawing board, which is holey it prevents the instruments from going "clean through the board."

According to an English contemporary, the process of making metal ribbon by pouring a molten stream on a rotating drum has been so developed that narrow bands only 0.001 inch thick may be produced at the rate of 2500 feet per minute, and a large machine just made in London has a dozen or more nozzles for giving as many ribbons at once. The ribbon is projected 10 feet or so, falling unbroken. The process has been applied to aluminum, zinc, tin, lead, copper, silver and gold.

AMERICAN MACHINIST

Issued Weekly by the

Hill Publishing Company

JOHN A. HILL, Pres. and Treas. ROBERT MCKEAN, Sec'y.

505 Pearl Street, New York.

Correspondence on mechanical subjects solicited and paid for. Name and address must always be given—not necessarily for publication.

Subscribers can have address changed at will. Give old and new addresses.

Subscription price $4 per year, postage prepaid, to any post office in United States, United States possessions and Mexico. $5.50 to Canada. $7 in all foreign countries except Europe and British possessions in Eastern Hemisphere.

Hill Publishing Co., Ltd., 6 Bouverie St., London, E. C., will serve all subscriptions for Europe and British possessions in Eastern Hemisphere. Price 30 Shillings for England. For all other countries in Eastern Hemisphere, 35 Shillings.

Entered at New York Post Office as mail matter of the second class.

Cable Address, "MACHINIST," N. Y.
Business Telegraph Code.

CIRCULATION STATEMENT

During 1908 *we printed and circulated* 1,205,750 *copies of the* AMERICAN MACHINIST.

Our circulation for June, 1909, *was (weekly, monthly and European)* 91,250.

July 1..... 34,000
July 8..... 19,000

This paper reaches 34,000 *separate readers each month and* 19,000 *each week.*

None sent free regularly, no returns from news companies, no back numbers. Figures are live, net circulation.

Contents

PAGE

The Smallest Successful American Aeroplane 49
Automobile Engine Cylinder and Piston Finishing Practice..... 52
A Pair of Odd Shaped Gears..... 55
A Planer Brace..... 55
Modern Iron Foundry and Materials Yard 56
Sizes of Pipes Without Mathematics..... 60
The Transmission of Power by Ropes.... 61
A Variable Speed Gear..... 67
Some Interesting Types of Drill Jigs.... 69
A Set of Bolt Heading Dies..... 72
Japanese Machinery Imports for 1907... 72
Practical Letters From Our Readers:
Turning Steel Gas Engine Cams on the Lathe....A Fixture for Bending Flat Stock on Edge....What Is a Good Running Fit....A Buzz Saw Safety Guard....A Casting Outliner.....73-76
Discussion of the Previous Question:
Hardening and Cooling Speeds of Steel ....Comparative Test of Two Shapers ....Industrial Education....Belt Feeds in England....A Variable Speed Heat Consumer....Another Belt Drive.... Method of Straightening Machine Tables....Transferring Holes.....77-81
Alloy Steels for Motor Car Construction.. 82
Convenient Drawing Board Lamp..... 86
Trade Opportunities in Ecuador..... 87
Fundamentals of the Apprenticeship Problem 89
New Tools and Machine Shop Appliances 90

The Fundamentals of the Apprenticeship Problem

Many reasons are given for the decay of the apprenticeship system, the chief, perhaps, being the growth of specialization and the influence of the labor unions. We have never been able to understand why or how the growth of specialization should have had such an influence, as this growth has not lessened the demand for trained men. It has lessened the demand for all-round men, and it is reasonable to suppose that it has thus interfered with an all-round system of apprentice training. The most that we can see in the way of legitimate effect of specialization is that it should narrow the training of the apprentice; that it should have done away with him we can see no reason for supposing.

A perfect illustration of this narrowing tendency is seen in the partial apprenticeship scheme of the National Machine Tool Builders' Association by which apprentices are to be trained at the start as specialists and we can see no reason for giving specialization the credit or the blame for any further influence than this.

As regards the influence of the unions the broad fact stands out that the problem of industrial education and training is just as acute in industries where the unions have little influence as in those where they have much, and so long as this is true those who lay the present situation to the influence of the unions show themselves to be ill-informed or blind.

The simple fact is that the American boy does not want to enter a factory for the purpose of learning a trade and for this there are, we believe, two reasons: First, the pay is too small, and second, the instruction is too poor.

During the past half century there has been a steady increase in the wages paid to skilled workmen but, except for a few conspicuous exceptions, there has been no such increase in the wages of apprentices. The standard wage for a first-year apprentice in this country at the present time is, we believe, about $3 per week—precisely what it was 40 years ago. The increase in the wages of skilled workmen has been, no doubt, made possible at least by improved methods of production. Because of these the production of wealth by the workman has been increased and his increased wages are the portion of this increase which has come to him. In the case of apprentices no such increase of production has taken place, and their wages have consequently remained stationary. The apprentice is pitchforked into the shop today just as he was a half century ago, and he is expected to pick up knowledge and skill as best he may now as then—the condition in this respect being, if anything, worse now than formerly.

The problem of the employer is to get apprentices and to keep them after he has obtained them. To do this we believe two things to be necessary: First, to pay them more, and next, to teach them better. To this the average employer will reply that he cannot afford to do either one, much less both, there being, in the belief of many, no profit in apprentices even at the existing scale of wages.

To speak somewhat paradoxically, the indications are that while the employer cannot afford to do either one of these things he can afford to do both, because the two are bound up together. Through more effective teaching the boys become profitable producers at a much earlier point in their apprenticeship and while they do not earn the increased wages at the start, as in fact they do not the smaller ones, they become efficient producers much sooner. This, at least, is the lesson that we learn from the training school which Mr. Alexander has installed at the Lynn works of the General Electric Company.

We are not rainbow chasers in this matter. Experience with systematic teaching under a shop instructor is still too limited to justify definite conclusions, but it is reasonable to say that this plan offers the most promising solution of the apprenticeship problem. How a boy ever learns a trade under prevailing conditions is to us a mystery. No one can deny that the possibilities of systematic teaching under a shop instructor are large; that, through this means, the boys will become profitable producers sooner than they otherwise would is a truism. The only uncertain point is the rate of this increased progress and the amount of increased wages which it will justify. If experience shall prove that this amount is sufficient to attract bright boys to the shops in sufficient number, then it solves the apprenticeship problem.

With such possibilities before the plan together with the fact that its adoption involves nothing but individual initiative, we believe it to be time for manufacturers to turn their attention to it in place of holding meetings and passing resolutions calling upon the general public to inaugurate a vast system of trade schools, the outcome of which is altogether problematical, the one certain thing about it being that a generation of agitation and effort will be required to accomplish anything effective.

Observations made in deep mines and artesian wells show that it gets about 1 degree hotter for about every 50 feet of descent. This increase is not regular, probably because different rocks conduct heat differently. In England the increase is 1 degree for 30 feet, but all over the globe where observations have been made the average is about 1 degree hotter for about 50 feet.

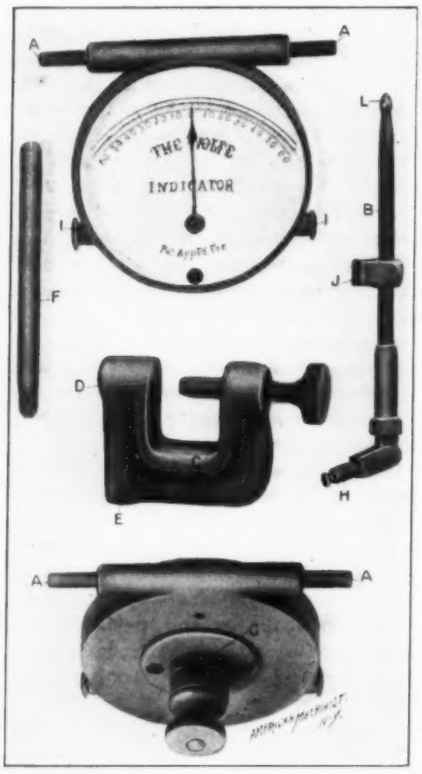
New Tools and Machine Shop Appliances

Showing New Ideas in Machine Shop Equipment That Make it Possible To Do Better Work at a Reduced Cost

THE LATEST INFORMATION

Test Indicator

This indicator has a dial graduated to read to thousandths and the capacity is 1/16 inch in either direction. It is readily applied to work in the lathe, miller, shaper, on the bench, etc. In use either contact point *A A* may be brought against the work, or the auxiliary arm *B* may be attached for internal and center-punch work. The clamp *C* has two holes tapped at *D* and *E* in either of which the threaded rod *F* may be inserted. This rod is slipped through hole *G* at the back of the indicator, and the nurled nut tightened sufficiently to hold the indicator which may then be readily turned to any position desired. The clamp *C* forms a convenient device for attaching the indicator to any suitable support. For inside work the end *H* of auxiliary arm *B* is inserted in either hole *I I*, and slotted head *J* placed over the end of plunger *A*. The indicator is adjusted to bring rod *B* parallel with the axis of the hole to be tested, and the end *L* brought into contact with the working surface. For centerpunch work rod *B* is turned half way around to bring the flat side of head *J* against plunger *A* and the pointed end *L* used in the punch mark which is being trued up. The maker is J. L. Wolfe, Bridgeport, Conn.



TEST INDICATOR

Forged Steel Lifting Jacks

The use of steel forgings in the making of lifting jacks is an indication of the tendency of the times toward high-pressure work. In the telescoping jack shown every metal part is of steel, the bottom of the cylinder being forged integral with the walls and eliminating the joint at this place.

FORGED STEEL LIFTING JACK

The pump works on both the up and down stroke and as the upper chamber has five times the volume of the lower, the ram can be run out to the load, or a light load lifted at high speed. For heavy lifts the pump is so arranged that the volume of liquid forced under the ram is automatically increased under a light load and reduced under a heavy load. When the load exceeds the rated capacity of the jack over 25 per cent. the by-pass valve is automatically on the next upward stroke of the pump, the tension of the spring being limited to the lifting power of one man on the jack. This combination gives a speed of 3/16 inch for each double stroke of the pump with no load and a movement of 1/32 inch under maximum load. These jacks are made by the Duff Manufacturing Company, Pittsburg, Penn.

Slabbing in an Automatic Screw Machine

The automatic screw machine is no longer confined to plain round work, as many are fitted with cross drilling and other attachments, which add much to their usefulness. The illustrations show a new attachment recently furnished by the National-Acme Company, Cleveland, Ohio, to the Cadillac Motor Car Company, of Detroit, Mich., for slabbing the sides of piece shown in the machine, at the point in front of the cutters in Fig. 1.

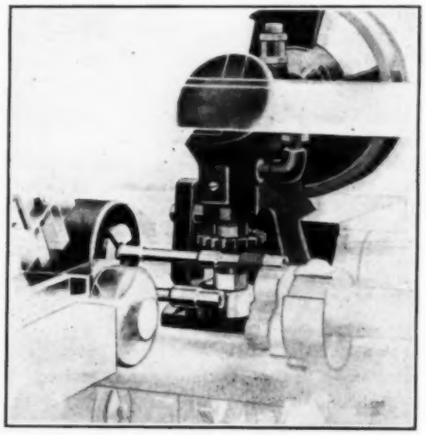


FIG. 1. FRONT VIEW OF ACME SLABBING ATTACHMENT

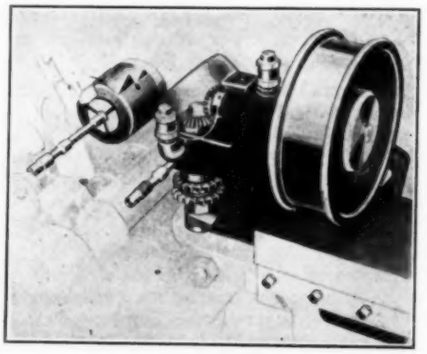


FIG. 2. REAR VIEW OF SLABBING ATTACHMENT

This attachment is fastened to the top of the cutoff tool slide and operates on the work in the third position. The two straddle mills on the vertical shaft are

driven by bevel gears from the pulley at the back and a special countershaft, although this can be eliminated and direct connection made with the die-spindle gears.

The milling operation takes place during the time required for the forming and milling operations in the first position and while the stock is being held stationary in the third position for the threading. In the case mentioned, this was put on a No. 53 "Acme" automatic, which is turning out pieces complete at the rate of 53 per hour, so that the slabbing takes no extra time whatever.

New Haven Engine Lathe

This lathe is built either with a quick change gear device as shown in Fig. 1 or with a planer feed box having 3 feeds as in Fig. 2. The first gives threads or feeds from 2 to 28 per inch while the latter has a range of 1, 2 and 4, the actual feeds being dependent on the gears used at the end of the lathe. Threads can also be cut, the range from 1 to 28 being obtained with but 9 change gears.

The simple feed box seems to be growing in favor and this design differs from the usual construction in the clutch control shown in Fig. 3. The feed lever controls two clutches on different shafts through the medium of two fulcrum pins 1 and 2. As shown, the lever is raised to its upper position with pin 1 as the fulcrum. Moving it toward *A* engages one clutch, toward *B* another clutch, each giving a different feed. Dropping the lever so that pin 2 bears in the upper notch allows the thread feed to be given by moving to *C*. This effectually prevents engaging more than one clutch at a time and the lever is prevented from dropping, except in the central position, by the small pins engaging in the slotted pin at the top. Multiple tooth clutches are used in place of a sliding key.

A splined screw is used in place of a feed rod, the drive being through bevel

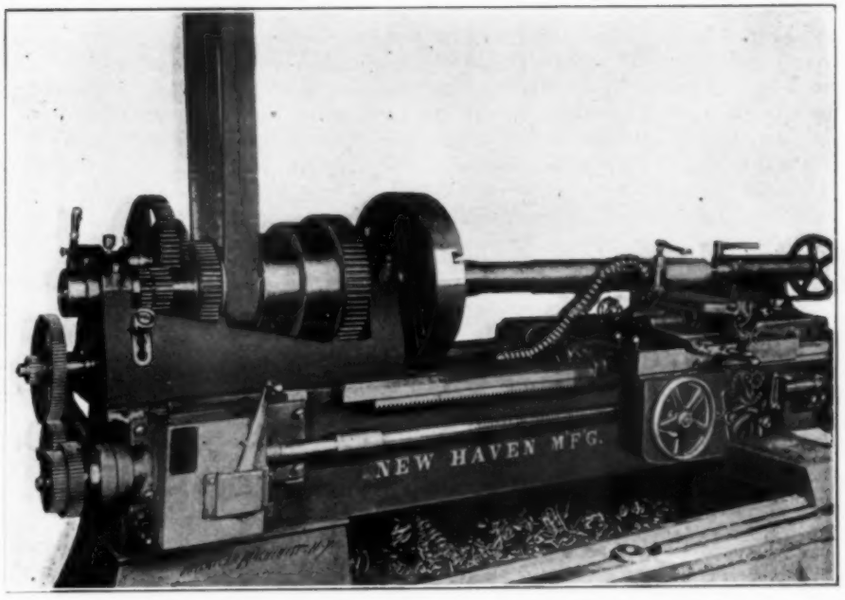


FIG. 2. THE LATHE EQUIPPED WITH PLANER FEED BOX

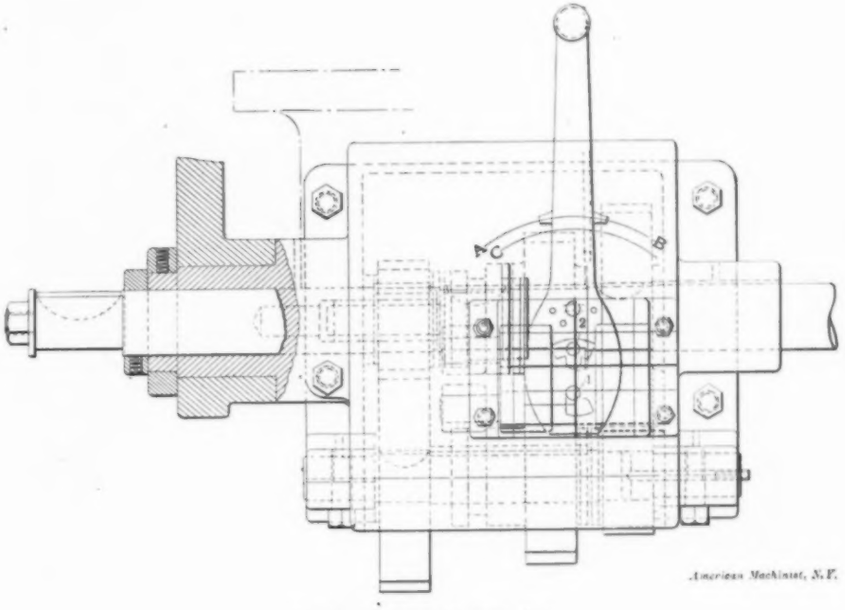


FIG. 3. DETAILS OF FEED BOX

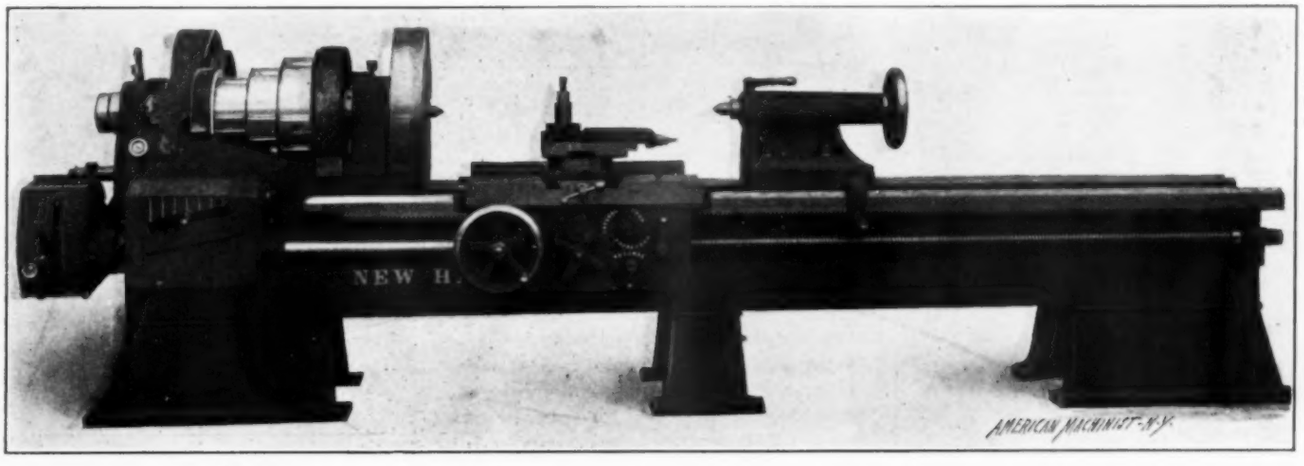


FIG. 1. 24-INCH SWING NEW HAVEN LATHE WITH QUICK CHANGE FEED BOX

pinions instead of a worm, and can be reversed for all feeds. The shifting fork interlocks with the half nut so that both cannot be engaged at the same time. The apron is of the double-wall type, cast in one piece, giving a double bearing to all studs and shafts. The hand wheel is heavy but can be disengaged when thread cutting by pulling it slightly forward. The feeds are through a friction controlled by the star wheel while the directions for different feeds to be obtained are cast on the apron so that no mistake need be made, even by a new man.

The lathe is double back geared and has nine spindle speeds for each countershaft speed, a two-speed counter, as used in their own shop, giving from 7½ to 333 revolutions per minute.

Fig. 2 shows the lathe at work on a piece of 5-inch 35-point carbon steel with a cutting speed of 75 feet a minute with a half-inch cut and a 3/32-inch feed.

The cone is locked to the spindle gear by means of a spring pin so that a wrench is not needed. The lathe is the latest product of the New Haven Manufacturing Company, New Haven, Conn.

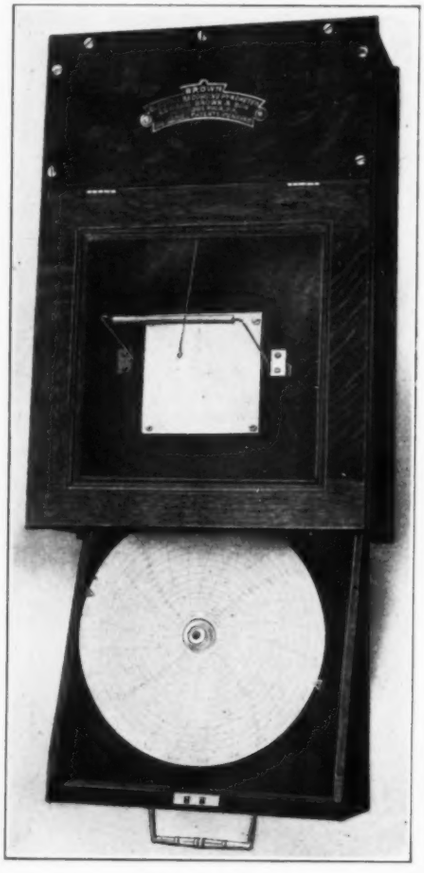
Telephones in the Shop

Although shop telephones are nothing new, they are not fully appreciated in many places and the time they can save is too often lost sight of. For this work the automatic telephone is especially adapted because of its independence of an operator, being available at any hour of day or night for communication between any portions of the plant. The set shown is of the push-button type for 12 stations and can be fastened to a wall or any convenient place. It will take but very little figuring to show the time that can be saved to all the executives of a shop if they can talk to each other without walking several hundred feet to do so. The set shown is made by the Western Electric Company, New York.

TELEPHONES IN THE SHOP

A New Electric Recording Pyrometer

The instrument shown has been recently designed by Edward Brown & Son, Philadelphia, Penn. It is constructed for use in conjunction with a thermo-couple as a thermo-electric recording pyrometer, but could be used for recording pressures of steam and blast, volts, milli-volts, etc.



ELECTRIC RECORDING PYROMETER

As a pyrometer, the complete equipment consists of a thermo-couple, consisting of two nickel alloy rods suitably insulated and protected, the recording electric pyrometer, and the leads or wire for connecting the thermo-couple and the recorder. The leads may be any length from 100 to 500 feet, and the same thermo-couple which generates the current for the recorder may also actuate an indicating instrument on the same circuit, but located near the furnace for the operator's assistance.

The electric recording pyrometer gage consists of a milli-voltmeter system carrying a small drop of ink on the pointer or needle. A large eight-inch chart of stiff white paper is raised once a minute by a powerful eight-day clock and touches the ink pen, making a small dot on the chart. These continuous dots form into a fine line, and as the pen is only in contact with the chart a very short time, the pointer is able to fluctuate readily with the rise or fall in temperature.

To remove the chart from the instrument without its striking the pointer or necessitating the moving of the system, the chart and clock mechanism are mounted inside a drawer. This drawer is carried on ways or guides that cause it to draw away from the pointer and not make a line across the chart. The milli-voltmeter and the clock mechanism are both inclosed in metal cases as an additional protection from dust. The record charts can be made to revolve once in twenty-four hours or seven days, as required.

A Convenient Welding Table

The Autogenous Welding Equipment Company, of Springfield, Mass., has designed a table of rather peculiar construction to fill a want in its particular class of work, the repair of broken parts by means of the oxy-acetylene torch. Fig. 1 shows this with a top thirty inches square with well arranged slots so that broken parts can be lined up and bolted

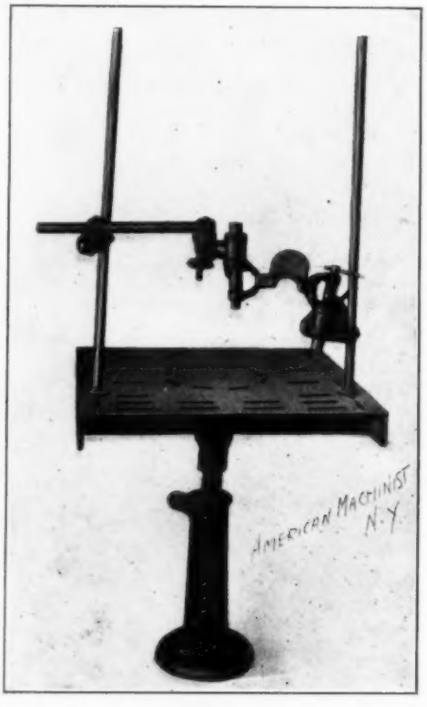


FIG. 1. CLAMPS FOR HOLDING WORK TO BE WELDED

into position. The top is carried on a ball which can be locked by means of a single screw in almost any position, as it can be tilted to a slight angle in all directions and to a right angle in one position. In any of these positions the table can be

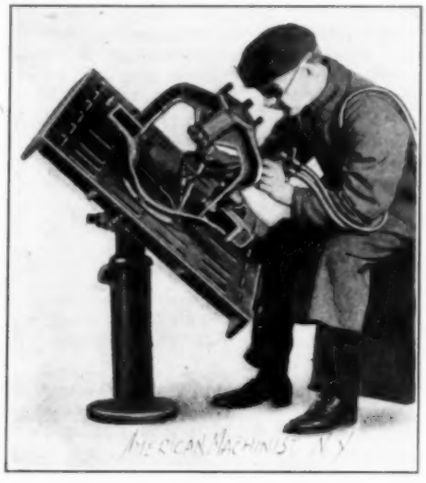


FIG. 2. A CONVENIENT WELDING TABLE

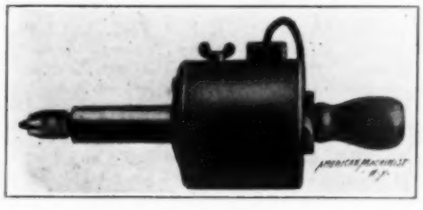
revolved so that any part of the work can be brought into any position for the operator to work on.

Two edges of the top have a flange projecting downward at right angles so that work to be held in a vertical position can be securely clamped. The top of the table is machined so that work can be lined up accurately, and the under side is well ribbed to avoid springing.

They also have a universal clamping fixture to be used in connection with this table so that broken parts can be held together in correct position to be welded or brazed; it being found by experience that more time is often consumed in lining up small broken parts than in their actual repair unless such clamps are used. This is shown in Fig. 2.

A "Simple" Breast Drill

The designer of this drill had his eye on the making of things as simple as possible, even to naming the machine. The

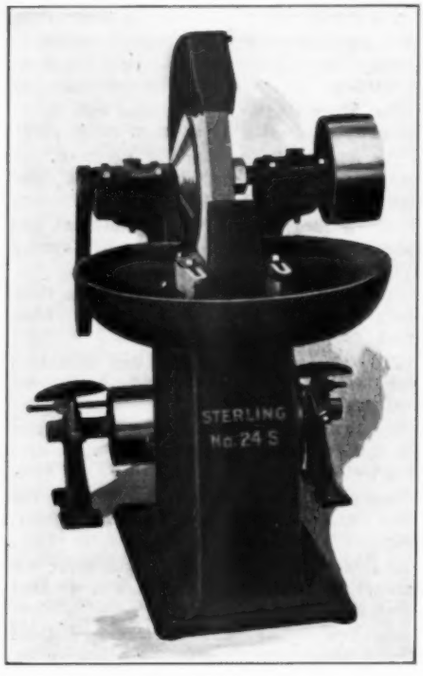


A "SIMPLE" BREAST DRILL

drill spindle has two long bearings, which are of phosphor bronze and can be easily renewed when worn. The whole machine can be taken apart by removing two nuts. All the electrical connections are attached to the main casing of the machine and remain undisturbed when it is taken apart for any reason. A snap switch on the side controls the starting and stopping of the motor. The motor is well ventilated, so as to remain cool in use on any work up to ¼-inch holes. It is made by the Willey Machine Company, Jeffersonville, Ind.

A Single Wheel Tool Grinder

This grinder has been designed for tool room needs, to give a machine which would be simple and at the same time effective in tool-room work. No pump is used to supply water to the wheel but a constant supply is maintained by a special



SINGLE-WHEEL TOOL ROOM GRINDER

device inside the frame. The water drains away from the wheel when it stops, keeping it dry and in balance. It carries a 2x 24-inch wheel but can be arranged for a wheel of 3-inch face if desired. It is made by the Sterling Emery Wheel Compnay, Tiffin, Ohio.

An interesting experiment to determine whether the strength of iron and steel was affected by magnetism was carried out at the Technical Institute of Belfast with the following reported result: Bars of mild steel and wrought iron 8 inches long by one-half to one inch in diameter were used, part of which were magnetized by being saturated in a solenoid. When tested the elongation of the magnetized parts decreased 3 to 16 per cent. and the average breaking load seemed to be increased.

British Patent Revocation Procedure

Some recent important orders, amending the previously followed procedure in actions to revoke patents, have been issued by the British Comptroller-General. These are in consequence of a recent judgment of Mr. Justice Parker. In all cases of application for revocation under section 27 the following procedure will in the future be adopted:

1. The applicant should, simultaneously with his application on Patents Form 24, leave at the office evidence by way of statutory declaration, stating the particulars upon which he relies in support of the allegations contained in the application; the copy of the application delivered to the patentee or his agent, in accordance with Patents Rule 78, should be accompanied with copies of such evidence.

2. The patentee should, within fourteen days from the delivery of such copy, or within such further time as the Comptroller may allow, leave at the office evidence by way of statutory declaration stating whether or not the allegations contained in the application are correct; and if they are incorrect, giving the particulars upon which he intends to rely in answer to the allegations made by the applicant. Copies of such evidence should at the same time be delivered to the applicant.

3. Should the applicant then decide to proceed with his application, he may then leave and deliver further statutory declarations in answer, in accordance with the provisions of the latter part of Rule 79.

4. The Comptroller will then intimate to the parties whether, having regard to the circumstances of the case, he considers it desirable and intends to hold a preliminary hearing on the question whether a *prima facie* case has been made in support of the allegations in the application, or whether he intends in ordinary course to deal at one hearing with the whole case, including the further questions whether the patentee can prove that the patented article or process is manufactured or carried on to an adequate extent in the United Kingdom, or can give satisfactory reasons why the article or process is not so manufactured or carried on.

5. Should the Comptroller think fit to hold a preliminary hearing as aforesaid, and as a result of such hearing decide that a *prima facie* case has been made in support of the allegations in the application, or should he determine to proceed in ordinary course to deal at one hearing with the whole case, including the further questions mentioned in head (4), then, and in either of the said cases, he will give to the patentee further time for leaving at the office and delivering to the applicant pursuant to Rule 79, evidence by way of statutory declaration with regard to such further questions, or either of them, and

will subsequently give to the applicant under Rule 79, and thereafter, if necessary, to the patentee under Rule 80, further time for leaving further evidence by way of statutory declaration with regard to such questions, or either of them in answer or reply, as the case may be.

6. In the event of an application under Section 27 being uncontested by the patentee, the Comptroller, in deciding whether costs should be awarded to the applicant, will consider whether proceedings under the Section might have been avoided if reasonable notice had been given by the applicant to the patentee before the application was filed.

For the above item we are indebted to *Engineering*, of London.

Personals*

Walter W. Hagerty, formerly with the National Transit Company, is engaged in general engineering work in Middletown, N. Y.

Edward P. Decker, formerly associated with the engineering staff of Westinghouse, Church, Kerr & Co., has recently become engineer with the Kemiweld Can Company, Detroit, Mich.

Chas. F. Schaeffer, proprietor of the Schaeffer Machine Works, Philadelphia, Penn., accompanied by Mrs. Schaeffer, will sail for Europe July 24, on the American line steamship "St. Louis."

The address of Henry Wyberg, at one time with the Autocar Company, of Ardmore, Penn., is wanted by a friend in England. Communication sent to this office will be forwarded to the party making the inquiry.

William H. Gerrish, formerly superintendent of the Travers Manufacturing Company, recently entered the employ of the Columbian Rope Company, Auburn, N. Y., as superintendent of the soft fiber department.

August Kittleberger, who for the past fifteen years has been associated with the Clayton Air Compressor Works, has been engaged by the American Air Compressor Works as superintendent of their works in Brooklyn, N. Y.

W. A. Reichert, for the past three years advertising manager for the Fort Wayne Electric Works, Fort Wayne, Ind., has resigned to accept a similar position with the Power and Illuminating Engineering Company, of Alliance, Ohio.

Forthcoming Meetings

International Association for Testing Materials, fifth congress, Copenhagen, Denmark, September 7-11.

*Items for this column are solicited.

Business Items

The Midvale Steel Company has placed an order with Tate, Jones & Co., Pittsburg, Penn., for Kirkwood oil burning equipment for open hearth furnaces.

Increase of business has compelled the Carlyle Johnson Machine Company, manufacturers of the Johnson friction clutch, to move to a new factory at Manchester, Conn., nine miles east of Hartford, on the Willimantic division of the N. Y., N. H. & H. R. R.

Business Opportunities

Edward T. Seifert, Reading, Penn., will build a one-story garage.

Fire destroyed the shops of the Pennsylvania Railroad at Belwood.

The Perfection Spring Company, Cleveland, Ohio, is building a new factory.

The Selden Motor Vehicle Company, Rochester, N. Y., will erect a new plant.

The Tabor (N. C.) Lumber & Crate Company wants machinery for making crates.

The Harley-Davidson Motor Company, Milwaukee, Wis., will build an addition.

The Mitchell (S. D.) Machine and Boiler Company is erecting an addition to its plant.

The Roseland Can Company, Rockford, Ill., manufacturing tinware, will erect a new plant.

The Syracuse(N. Y.) Aluminum and Bronze Company will erect a new foundry building.

The plant of the Kings County Iron Company, Brooklyn, N. Y., was burned. Loss, about $25,000.

The factory of the Globe Box Company, Waterloo, Iowa, was destroyed by fire. Loss, about $15,000.

The Lobdell Car Wheel Company, Wilmington, Del., will erect a new building to be used as a roll shop.

Two large additions will be built to the stove foundry of the White-Warner Company, Taunton, Mass.

The Moline Plow Company will erect additional buildings at Freeport, Ill., to cost about $125,000.

The Power and Mining Machinery Company, Cudahy, Wis., is planning extensive additions to its plant.

The R. J. Preuss Company, Milwaukee, Wis., mattress manufacturers, will erect a new $20,000 factory.

The Keystone Fence Company, South Bartonville, Ill., spend $60,000 in increasing the capacity of its plant.

The American Roll and Foundry Company, Canton, Ohio, will build additions to its foundry and machine shop.

The Safety Car Heating and Lighting Company, Jersey City, N. J., will increase the capacity of its power plant.

It is reported that plans are under way for a large new roundhouse for the Canadian Pacific Railway at London, Ont.

The Rubber & Celluloid Harness Trimming Company, Newark, N J., has taken out a permit for a new $30,000 factory.

The Reliance Ball Bearing Door Hanger Company, Brooklyn, N. Y., is to make improvements and install more machines.

The Peteler Car Company, Minneapolis, Minn., succeeding the Kilgore-Peteler Company, is preparing to enlarge its plant.

The plant of the Little Mashell Lumber Company, Eatonville, Wash., was destroyed by fire, causing a loss of about $40,000.

The Union Metallic Cartridge Company, Bridgeport, Conn., has applied for permit to build a four-story addition to its plant.

The Delaware, Lackawanna & Western Railroad is commencing work on a new car shop at East Buffalo. This will cost over $100,000.

The Driggs-Seabury Ordnance Corporation has awarded contract for the construction of addition to its plant to cost about $50,000.

The Bristol (Conn.) Engineering Corporation, which manufacturers taxicabs and automobile parts, is seeking a site for a new plant.

The Wyman Stave and Heading Company, Meridian, Miss., will enlarge its plant and install an equipment for the manufacture of barrels.

The Hyatt Roller Bearing Company, Harrison, N. J., will start work on the erection of a three-story addition to cost about $20,000.

An addition is being built to the machine shop of Bickford & Washburn, Greenfield, Mass., who build a tap-threading machine and do machine jobbing.

The La Belle Iron Works, Steubenville, Ohio, will add six mills to its present sheet plant and some tin mills with tinning plant may also be added.

The Northwestern Steel and Iron Company, Eau Claire, Wis., will have the addition to its foundry completed this summer and some new equipment installed.

The Isthmian Canal Commission, Washington, D. C., will receive bids up to 10:30 a.m. July 19 for steel castings, pipe machines, etc., as per Circular No. 520.

The Daniel H. Stoll Company, Buffalo, N. Y., manufacturing presses, dies, etc., will build a two-story addition, and instal new machinery, including drills, lathes, etc.

The Independent Steel Company of America has awarded a contract for the construction of buildings at Kenova, W. Va. Arthur Hirsch, House building, Pittsburg, is manager.

The Baltimore & Ohio Railroad will build a new roundhouse, new building for machine department, blacksmith, pipe and tin shops, etc., at Benwood Junction, expending about $300,000.

The Isthmian Canal Commission, Washington, D. C., will receive bids up to 10:30 a.m., July 26, for locomotive coaling cranes, motor car, speed-well castings, etc., as per Circular No. 521.

The Salem Iron Works, Winston Salem, N. C., wants to buy an air compressor of about 100 cubic feet per minute. New preferred, but second hand, in perfect order, would be considered.

The Dain Manufacturing Company, of Ottumwa, Iowa, is erecting a plant in Welland, Ont., for the manufacture of hay stackers, unloaders, presses, etc. Considerable equipment will be needed.

The Cutler-Hammer Manufacturing Company, 50 Church Street, New York, has filed plans for a new five-story factory to cost $105,000. The company manufactures electric-controlling devices, etc.

The Indiana Brass and Bronze Company, Marion, Ind., manufacturing brass, bronze and aluminum castings, is erecting some additions, which will double its capacity. Finishing department will be added.

It is reported that the Carriage Steel Company will move the Schoen Pressed Steel Wheel plant from McKees Rocks to West Homestead, and erect near it the proposed $1,000,000 plant for making the Slick wheel.

The H. A. Moyer Company, Syracuse, N. Y., has awarded contract for the erection of a new five-story building to be equipped with

modern machinery for manufacturing its automobiles. A blacksmith shop will also be built.

The Fort Smith, Arkansas & Southwestern Railway Company, recently chartered, will build from Arkoma, Okla., southwest to Wilburton, 64 miles. Cost, about $7,000,000. E. D. Bedwell and J. T. Neilson, of Fort Smith, Ark., are directors.

The National Coning Company, recently incorporated, is said to be looking for a site in Indianapolis, Ind., on which to erect a plant for the manufacture of machinery for making paper bottles. M. P. Woody and W. A. Scott, of Indianapolis, are stockholders.

Plans for a new industrial school at Worcester, Mass., have been accepted. Building will be erected and equipped with machine shop, blacksmith shop, tool-making and diecutting room, casting room, etc. M. P. Higgins, of the Norton Company, is on the building committee.

The Navy Department, Bureau of Supplies and Accounts, Washington, D. C., will open the following bids: July 20—turret lathe (schedule 1419), spring balances (schedule 1434), tachometer (schedule 1429), pneumatic sand rammer (schedule 1421), metallic belt lacing, hack-saw blades, twist drills, oiler sets, pipe sets, shovels, hand taps, turnbuckles (schedule 1432), steel plate, steel beams, steel rods (schedule 1431); July 27—brass angle valves, fire hose, fire extinguisher (schedule 1410); Aug. 3—electric jib cranes (schedule 1394), gasolene engines (schedule 1411), forges (schedule 1426), machine screws, wood screws (schedule 1425); Aug. 3—armature banding and field-coil binding machine (schedule 1438).

The Navy Department, Bureau of Supplies and Accounts, Washington, D. C., will open the following bids: July 13—electrical supplies (schedule 1395), gaskets, scales (schedule 1396), ash-hoisting engine (schedule 1391), generator set (schedule 1392), vertical duplex pump (schedule 1390), aluminum (schedule 1408), bronze, copper (schedule 1405), sheet steel (schedule 1402), steel for machinery (schedule 1399), steel rivets, washers (schedule 1402), bushings, gages, oil cups, brass unions, globe valves, gate valves (schedule 1404), brass, copper pipe (schedule 1405), iron or steel pipe, steel tubes (schedule 1403), wrought-iron pipe (schedule 1397, 1399), anvils, chisels, drills, forges, grindstones, hack-saw blades, hammers, nippers, squares, rules, tap and dies, vises, wrenches (schedule 1400); July 20—universal milling machines (schedule 1412), furnishing and installing boiler, piping, etc. (schedule 1393).

New Incorporations

Clark Foundry Company, Rumford, Me., has been organized to manufacture and deal in machines, tools, etc. Capital, $50,000. P. B. Clark, president.

The Leslie Manufacturing Company, Boston, Mass., has been incorporated to manufacture tools of all kinds. Capital, $500,000. Frank A. Burbeck, Malden, Mass., president.

City Paper Company, Peoria, Ill., has been incorporated. Capital, $30,000. Incorporators, D. Johnston, B. C. Jones, W. A. Ryan. Will manufacture paper and paper-mill supplies.

Victor Flange Company, Buffalo, N. Y., has been incorporated to manufacture flanges and other plumbing supplies. Capital, $10,000. Incorporators, J. S. Candee, F. T. Reynolds, Cornelius Coghlan.

Maine Automatic Vending Machine Company, Portland, Me., has been incorporated to manufacture and deal in vending machines. Capital, $10,000. Frank H. Jordan, South Portland, president.

The Herron-Webb Engineering Company, Monongahela, Penn., has been incorporated to manufacture machinery and appliances. Capital, $100,000. Incorporators, D. C. Herron, S. C. Webb, Monongahela, and others.

Security Electric and Construction Company, Augusta, Me., has been incorporated to manufacture mechanical and electrical machines. Capital, $1,000,000. E. M. Leavitt, Winthrop, Me., president and treasurer.

Bishop, Delano & Company, Chicago, Ill., have incorporated to manufacture automobiles, accessories and electrical supplies. Capital, $50,000. Incorporators, H. J. Bishop, J. K. Delano, Jr., F. J. Beier.

R. S. Pullen Manufacturing Company, Camden, N. J., has been incorporated to manufacture accountants', draftsmen's and engineers' instruments. Capital, $100,000. Incorporators, R. S. Pullen, E. J. Evans, H. I. Magee.

The Parkersburg & Pocataligo Valley Railroad Company has been chartered to build a railroad from Parkersburg to a point near Charleston, W. Va. Incorporators, R. E. Bills, John W. Dudley, of Pakersburg, W. Va., and others.

The Hannibal & Northern Missouri Railroad has been chartered to build a line from Hannibal to Kirksville, Mo. Capital, $2,000,000. Joseph W. Latimer, of Chicago, is principal stockholder. J. Walter Farrar and Frank O. Chesney, of Kansas City, Mo., are also interested.

New Catalogs

Triumph Electric Company, Cincinnati, Ohio. Bulletin No. 351, illustrating and describing induction motors.

Keuffel & Esser Company, Hoboken, N. J. Circulars describing blueprint papers and Click paragon pen.

Morrow Manufacturing Company, Elmira, N. Y. Circular illustrating and describing Morrow 3-in-1 chuck.

Mesta Machine Company, Pittsburg, Penn. Pamphlet describing rubber-mill machinery. Illustrated, 8 pages, 6x9 inches.

New Haven Manufacturing Company, New Haven, Conn. Catalog describing lathes. Illustrated, 58 pages, 6x9 inches, paper.

Link-Belt Company, Nicetown, Philadelphia, Penn. Bulletin No. 84, describing "Maximum" silent chain. Illustrated, 12 pages, 6x9 inches.

The Triumph Electric Company, Cincinnati, Ohio. Card for hanging on wall containing directions for testing polyphase induction motors.

Tate, Jones & Company, Pittsburg, Penn. Pamphlet containing "Ready Reference Tables" for using natural gas as a fuel. Eight pages, 6x9 inches.

Emerson Electric Manufacturing Company, St. Louis, Mo. Bulletin No. 3216, illustrating and describing bipolar ventilated motors. 8 pages, 7x10 inches.

The Long & Allstatter Company, Hamilton, Ohio. Catalog No. 21, describing power punching and shearing machinery. Illustrated, 208 pages, 7x10 inches, paper.

F. Wesel Manufacturing Company, 10 Spruce Street, New York. Catalog D, describing photo-engravers' machines and appliances. Illustrated, 130 pages, 7½x10 inches, paper.

Electric Welding Products Company, Cleveland, Ohio. Book entitled, "Valve Stems and Other Electrically Welded Products." Illustrated, 16 pages, 5x 7 inches, paper. Booklet entitled, "Finished Steel Bolts and Screws." Illustrated, 16 pages, 5x7 inches, paper.

General Electric Company, Schenectady, N. Y. Bulletin No. 1909, describing Curtis steam turbines for low pressure and mixed pressure. Illustrated, 12 pages, 8x10½ inches. Bulletin No. 4662, describing Thomson recording wattmeters for switchboard service. Illustrated, 20 pages, 8x10½ inches.

Want Advertisements

Rate 25 cents per line for each insertion. About six words make a line. No advertisements abbreviated. Copy should be sent to reach us not later than Friday for ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded, they will be destroyed without notice. No information given by us regarding any advertiser using box number. Original letters of recommendation or other papers of value should not be inclosed to unknown correspondents. Only bona-fide advertisements inserted under this heading. No advertising accepted from any agency, association or individual charging a fee for "registration," or a commission on wages of successful applicants for situations.

Miscellaneous Wants

Caliper list free. E. G. Smith, Columbia, Pa.

We buy and pay royalty for good patented machine or tool. Box 282, AMER. MACH.

Hand power bending tools, labor-saving, money-making, Estep & Dolan, Sandwich, Ill.

Light, fine machinery to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

A large foundry and machine shop desires to add to present lines of manufacture. Box 126, AMERICAN MACHINIST.

Machines designed; automatic special. Practical working drawings. C. W. Pitman, 3519 Frankford Ave., Philadelphia, Pa.

Special machinery accurately built. Screw machine or turret lathe work solicited. Robert J. Emory & Co., Newark, N. J.

Light and medium weight machinery and duplicate parts built to order; tools, jigs, etc. MacCordy Mfg. Co., Amsterdam, N. Y.

We design and build all kinds of light machinery, including dies, fixtures, tools and model work. The Matson Machine Co., Bethel, Vermont.

Wanted—Designs and prices of machines for tapping iron pipe fittings two to six inch. Box 126, AMERICAN MACHINIST.

Metal specialties manufactured; models, dies and special machinery. Inventions perfected; correspondence solicited. Box 362, AMERICAN MACHINIST.

Wanted—To sell or negotiate machine patent, etc.; highest possible endorsements. $10,000 to $25,000 backing required. "Building," 808 N. C. Ave., Washington, D. C.

I have an unusually good proposition. Wish to connect with firm desiring additional line of manufacture. Would consider organization of new company. Box 387, AM. MA.

Well equipped establishment would like to manufacture small machines or metal specialties of any kind; also has facilities for marketing such goods. Box 372, AM. MACH.

A large English firm of machine-tool importers having showrooms and offices in Great Britain, France, Italy and Japan, is wanting good agencies for machine tools of all kinds. Apply Box 189, AMERICAN MACHINIST.

Situations Wanted

Classification indicates present address of advertiser, nothing else.

DELAWARE

Mechanical draftsman, experienced mostly on machine tools, wishes to change. Box 338, AMERICAN MACHINIST.

FOREIGN.

Selfstarting Motors (Patented) — Practical young man desires to join first class electrical firm (alternating or three-phase current) for the purpose of introducing new promising device in connection with self-starting motors. Offers should be addressed "K. G. U.," 258 F. Rudolf Mosse, Cologne, Germany.

ILLINOIS

Foreman with superintendent capability desires change; A-1 mechanic with the push and executive ability; age 29; present position 5 years; best references. Box 385, AMERICAN MACHINIST.

MASSACHUSETTS

Wanted—Position as master mechanic in paper mills; have had eleven years' experience in large paper mills as foreman of repair department. Box 356, AMER. MACHINIST.

Position (eastern concern) as foreman of model or tool room, by a thoroughly competent, highly recommended and experienced man; 17 years a gage and model maker; unusually good references as to ability as workman and foreman. Box 389, AM. MACH.

Graduate M. I. T. desires change in responsible position; experience, 20 years as designer mechanical engineer and superintendent on variety of work including interchangeable manufacturing; best of references. Box 351, AMERICAN MACHINIST.

MICHIGAN

Mechanical engineer wants position on executive force with some car building, gas or steam engine building or structural steel plant; technical graduate; eleven years' practical experience; age 33; middle or far west preferred. Box 384, AMERICAN MACHINIST.

NEW JERSEY

Mechanical engineer, graduate, with several years' experience in general machinery, gas engines, automobiles and pumping machinery, desires responsible position. Age 28. Box 390, AMERICAN MACHINIST.

Position as manager or superintendent by a manager of a plant comprising foundry, machine and pattern shops doing a general contract work, heavy and light machinery and foundry on gray and charcoal iron castings. Can show results with a plant of any size. Box 374, AMERICAN MACHINIST.

Man with 20 years' experience as superintendent and manager of large machine works is open for an engagement August 1. Applicant is fully qualified to assume entire charge of office and works as its official head. Have good executive ability, good organizer and can produce maximum amount of work at minimum cost. Box 371, AMER. MACHINIST.

NEW YORK

Position wanted by engineer with 16 years' practical experience; competent and experienced as superintendent of design, construction and operation of complete equipment for producing interchangeable parts for complicated mechanism. Box 367, AMER. MACH.

Wanted—A position as foreman pattern-maker; good organizer and know how to handle men; well experienced on valves, cocks, marine, electric and furnace work; 18 years' experience; 35 years of age; can furnish first-class references. Box 383, AM. MA.

Mechanical engineer, age 32, technical graduate, expert designer and inventor of automatic machinery, jigs, fixtures and tools; worked seven years as machinist and nine years as draftsman; at present chief draftsman for large automobile factory, wishes a change; A-1 reference. Box 382, AM. MA.

Help Wanted

Classification indicates present address of advertiser, nothing else.

CANADA

Wanted—First-class toolmakers and machinists, accustomed to automobile, jig and fixture work. Apply Reo Motor Car Co. of Canada, Ltd., St. Catharines, Ont.

Mechanical engineer wanted for charge of designing and drafting office of large engineering works; give experience. Address, Canada Foundry Company, Ltd., 212 King St., West, Toronto, Canada.

Wanted—Cream separator manufacturing company wants experienced and energetic foreman to take charge of machine shop; salary $100 per month; position permanent to the right man. Applicants will state age, experience and give references. Box 373, AMERICAN MACHINIST.

CONNECTICUT

Wanted—A new company starting its factory in Connecticut desires applications for employment from draftsmen, foremen, toolmakers and general machine operators. The work is along the line of adding machines, firearms and typewriters, requiring interchangeable parts and high grade workmanship. Men having experience in this line of work, who can prove themselves capable men, are desired only. To such men permanent positions are offered, with ample opportunity for advancement. In reply, give age and references, which will be treated confidentially, if so desired. Box 314, AMERICAN MACHINIST.

ILLINOIS

Draftsman wanted; familiar with automobile engine and transmission work. Permanent position and liberal salary to the right man. The Buda Foundry and Mfg. Co., Harvey, Ill.

INDIANA

Two experienced foremen for machine and assembling rooms, manufacturing gasolene motors. Give reference, experience and age. Box 262, AMERICAN MACHINIST.

Wanted—A man as foreman of hardening department. One who has had experience in hardening fine punches and dies and case hardening small parts of carbon and nickel steel. State age, experience and give reference. Box 369, AMERICAN MACHINIST.

MARYLAND

Wanted—Three or four first-class draftsmen on heavy general machinery, structural and general arrangement work. Address Ellicott Machine Company, Baltimore, Md.

Wanted—Thorough, natural born, hustling mechanic to take hold and run shop where 25 to 30 men are employed; must be able to show men how practically without too much theoretical talk. Have well equipped shop, run ten hours per day; each man handling as many machines as he can advantageously. Good position for right man, but he must make good in quantity and quality of work turned out. State age, salary expected on start. Fifteen miles from Baltimore. F. X. Hooper, Glenarm, Md.

MICHIGAN

Wanted—A few first-class toolmakers on small work; good wages and steady employment for competent men. Box 278, AM. MA.

NEW JERSEY

Tool and die makers. Only first-class men need apply. Sloan & Chace Mfg. Co., Ltd., Sixth Ave. and North 13th St., Newark, N. J., near Roseville Ave. Station of D. L. & W. R. R.

Wanted—Man accustomed to setting up for Brown & Sharpe and Cleveland automatic screw machines, for large shop in New Jersey; state experience and wages expected. Address Box 379, AMERICAN MACHINIST.

Wanted—A tool draftsman on small, fine intricate work, for large shop in New Jersey. Only men of experience on the above line of work need apply. In answering state experience and wages expected. Address Box 378, AMERICAN MACHINIST.

NEW YORK

Draftsman—Experienced mechanical draftsman. Apply Marks & Woodwell, Consulting Engineers, 103 Park Ave., New York.

Wanted—A firm, long established, employing 2000 men desires a thoroughly practical and efficient general machine shop foreman; must be capable of satisfactorily handling sub-foremen and be able to supervise the output of 400 machinists. Unless at present employed will not be considered. Address Box 361, AM. MA.

Die maker as department foreman. Extensive general experience in die making essential. Bright, energetic mechanic for steady job. Applicants please state experience. Niagara Machine & Tool Works, Buffalo, N. Y.

Wanted—A young man as stenographer in a New York house, with a knowledge or taste for machinery; must reside in the vicinity of New York City. Future position, that of machinery salesman. Box 375, AMER. MACH.

Wanted—In a technical school, a man to teach architectural and mechanical drawing; one who has had practical experience. Apply by letter, giving qualifications in full, "Instruction Committee," 36 Stuyvesant Street, New York City.

Wanted—An established punch and die business can use the services of a "side line" salesman; territory within a radius of 50 miles of New York City. This is a first-class opportunity for anyone having a trade among punch and die users. Box 376, AM. MACH.

Wanted—An expert on hardening and tempering; one with broad experience and a master of the business; a steady all-year-around position is offered with best of conditions by an old established firm. Give experience in detail and wage expected. "P. R. S.," AMERICAN MACHINIST.

OHIO

Wanted—Machinists; only good men need apply; crank, lathe, planer, boring mills and bars and radial drill, Jones & Lamson machine and lathe; increasing force, steady work, good wages. Box 388, AMER. MACH.

PENNSYLVANIA

Machinists wanted. Lathe, boring mill and floor hands, air compressor work. The Blaisdell Machinery Co., Bradford, Pa.

Wanted—Metal patternmaker. In making application give experience and wages expected. Box 386, AMERICAN MACHINIST.

Salesman Wanted—Man thoroughly experienced; A-1 in buying and selling machine tools, as used in machine shop equipment. A. J. Kensler, 491 N. Third St., Philadelphia.

Designer wanted familiar with typewriter and adding machine design; exceptional opportunity for an industrious and accurate worker. Address, giving full particulars, Box 381, AMERICAN MACHINIST.

Wanted—A good live agent in every shop or factory in the U. S. to sell one of the best known preparations for removing grease and grime from the hands without injury to the skin. Absolutely guaranteed. An agent can make from $5.00 to $25.00 over and above his regular salary. This is no fake. Write for free sample and agents' terms. The Klenzola Co., Erie, Pa.

Mechanical Drawing—An eastern college will have a position open about September 1st for a technical graduate as junior instructor of mechanical drawing. Applicant must state age, education, drawing office experience, with references and salary expected. Box 370, AMERICAN MACHINIST.

Office assistant to works manager—I want a young man, 20 to 25, good draftsman with factory experience, mechanical ability, some mathematics, knowledge of factory and office systems, good address and habits, tactful, quiet, ambitious, quick. Technical education, experience as stenographer or in operating typewriter, comptometer, slide rule, etc., desirable, though not essential. How many of these qualifications have you? State fully: age, education, experience, references, if married, salary required, when available. Business, light drawn and stamped-metal work exclusively. Address "Works Manager," Box 380, AMERICAN MACHINIST.

VIRGINIA

Wanted—To teach drawing in a State School of Technology; a graduate in architecture from a German technical school; an excellent opportunity for a young man desiring to make teaching his profession; must be particularly competent in free-hand drawing. Box 377, AMERICAN MACHINIST.

WISCONSIN

Reliable machinists who desire steady employment in an automobile factory located in a cool, healthful, small city are advised to call, ready for work, at any time within four months, at the Rambler factory, Kenosha, Wis.

Alphabetical Index to Advertisers

	PAGE
Acme Machinery Co.	119
Adams Co.	124
Almond Mfg. Co., T. R.	106
American Emery Wheel Wks.	94
American File Sharpener Co.	111
American Gas Furnace Co.	109
American Pulley Co.	105
American School of Correspondence	93
American Tool Works Co.	8
American Tube and Stamping Co.	127
American Wood Working Machinery Co.	120
Armstrong-Blum Mfg. Co.	103
Armstrong Bros. Tool Co.	121
Automatic Machine Co.	114
Baker Bros.	95
Barnes Co., Wallace	120
Barnes Co., W. F. & John	14
Barnett Co., G. & H.	50
Bath Grinder Co.	81
Baush Machine Tool Co.	7
Bay State Stamping Co.	120
Beaman & Smith Co.	15 and 106
Becker Milling Machine Co.	23
Bemis & Call Hardware and Tool Co.	115
Besly & Co., Chas. H.	121
Betts Machine Co.	6
Bignall & Keeler Mfg. Co.	98
Bilgram Machine Wks.	97
Billings & Spencer Co.	120
Blaisdell Machinery Co.	113
Blanchard Machine Co.	118
Bliss Co., E. W.	31
Blount Co., J. G.	94
Boker & Co., Hermann	79
Boston Gear Works	96
Bradford Machine Tool Co.	5
Bradley, C. C.	99
Bristol Co.	4th cover
Brown & Co., R. H.	106
Brown & Sharpe Mfg. Co.,	88, 89 and 4th cover
Browning & Co., Victor R.	104
Brubaker & Bros., W. L.	113
Buffalo Fdry. & Machine Co.	95
Bullard Machine Tool Co.	49
Butterfield & Co.	115
Caldwell & Son Co., H. W.	105
Carborundum Co.	26
Card Mfg. Co., S. W.	31
Carpenter Tap & Die Co., J. M.	118
Carter & Hakes Machine Co.	105
Carver File Co.	120
Chambersburg Engineering Co.	119

Making the Colt Automatic Pistol

The Methods Used in Working the Parts out of the Solid so as to Avoid Brazed or Screwed Joints. Interesting Features of the Armory

EDITORIAL CORRESPONDENCE

The Colt Armory, as it used to be called, has long been one of the landmarks of Hartford, Conn., and from its Moorish dome to the construction of the buildings, it must have been a marvel at the time it was constructed, something over 40 years ago. The main shop or East Armory is 500 feet long by 60 feet wide, is of substantial brick construction, the floors of arched brick supported on iron beams, as can be seen in Fig. 1.

Built beside the Connecticut river it was at the mercy of freshets in the spring, had it not been for the very substantial dike which was built to protect it, and on this dike which Colt built ran the railroad to connect the factory with the main line of road up in the city. This dike had to be protected by trees, and willows were planted as being the natural growth for such a place. The cuttings from these gave just the material for baskets, so Colt brought over some Swiss basket makers, built a basket factory and also some very picturesque houses for them on the order of the chalet of their native land. The incident simply shows the enterprise and the far-reaching interest taken by Colt in his commercial ventures.

This shop, for years, had the distinction and still has, with but one exception that we know of, of having a cast-iron line shaft and no pulleys. The latter part is not true at the present time as the necessity for higher speeds has led to the putting of pulleys over the shafting. As can be seen in Fig. 1 the shafting is really a series of cast-iron drums, 9 feet long, 12 inches in diameter and about ⅜ inch thick. Each bearing is the connecting link between the sections and is about 4 15/16 inches in diameter by 10 inches long, fitting into the ends of the drums and being fastened to them by screws.

This shaft runs through the center of the shop on each floor and on the second floor, the one that is level with the top of the dike, is the power plant, consisting of two pairs of Colt engines Porter-Allen type, coupled direct to the shaft and driving it 130 turns a minute. This is in the center of the shop and the shafting above and below is driven by belts running up and down from this point. The object of this large shafting was to avoid the use of pulleys in this class of work, where machines are grouped as closely as can be seen in Fig. 2, over 2500 machines being in operation. There are advantages in this method, as it avoids belts getting down between pulleys on the main shaft, but it also has drawbacks, as is apt to be the case with any marked departure from regular practice.

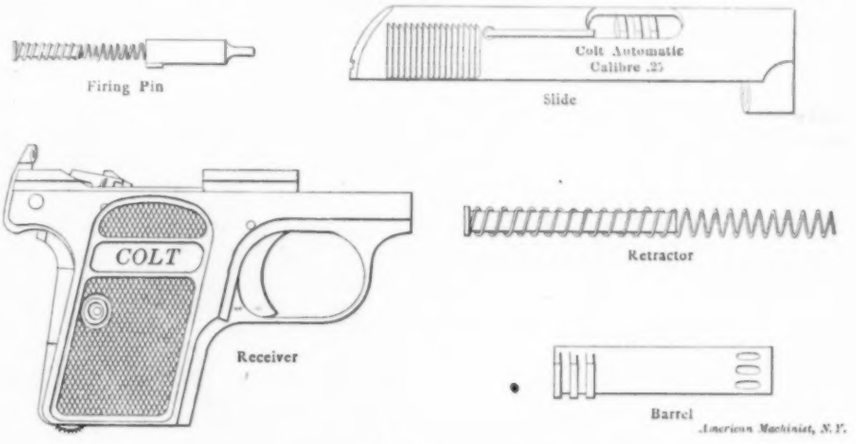


FIG. 3. THE MAIN PARTS OF THE COLT PISTOL

It is nearly 75 years since Samuel Colt whittled out his wooden model for the now famous revolver, and in order to still lead the procession, the automatic pistol was designed in larger sizes some years ago, being the first on the American

FIG. 1. THE COLT SYSTEM OF SHAFTING

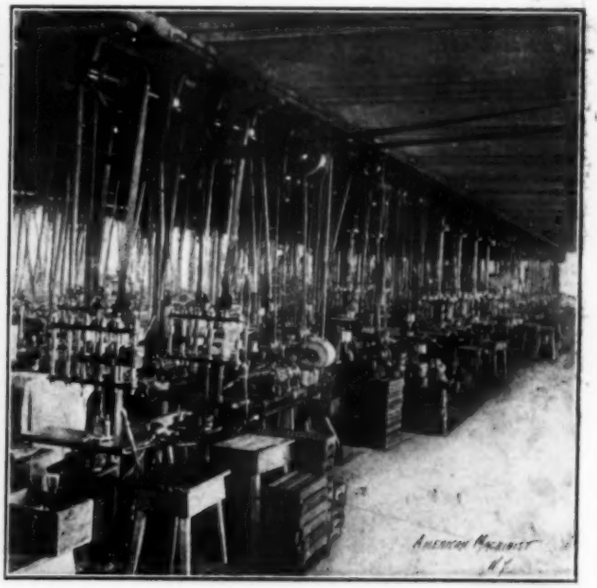


FIG. 2. THE WAY TOOLS ARE SPACED TO SAVE ROOM

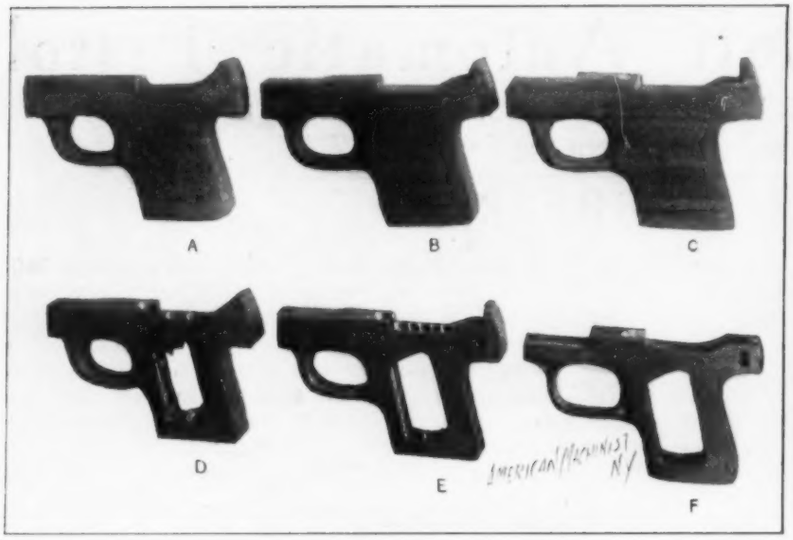


FIG. 4. SIX STAGES OF THE RECEIVER

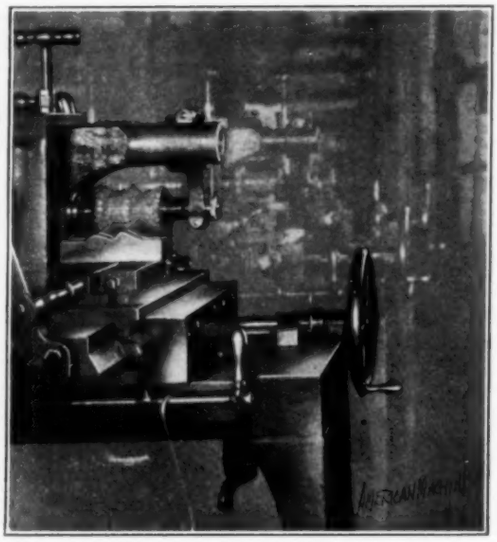


FIG. 5. MILLING MACHINE

market and now being made in five sizes, the smallest, 0.25 caliber and firing six shots as fast as the trigger can be pulled, has recently been put on the market. Although so small as to fit in the vest pocket it will shoot a bullet through four and one-half pine boards, each ⅞ inch thick. The completed arm weighs 13 ounces and is only 4½ inches long. The main parts of this are shown in Fig. 3.

THE RECEIVER OR FRAME

The receiver or frame is made from a special gun steel which comes in bars ⅞x2½ inches and is cut off ready for the drop forger, who leaves it, as shown in *A*, Fig. 4, where it weighs about 1 pound and 3 ounces. After pickling in sulphuric acid to remove scale it begins a tour of a group of milling machines, a few being shown in Fig. 5, which first slab-mill the sides, then form the outlines with gang cutters and leave it ready for the drills to carry on the good work. Then the recoil hole is drilled, the holes that limit the magazine and the block is then cut out, as in Fig. 6, by the mills or saws working in from the sides.

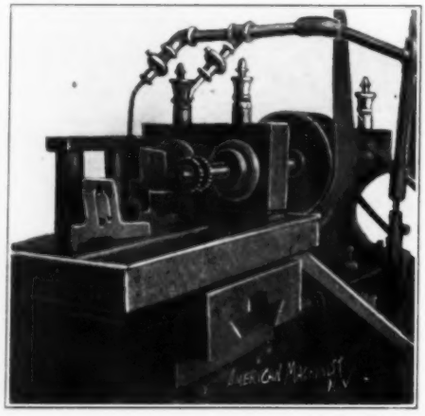


FIG. 6. MILLING OUT THE FRAME FOR MAGAZINE

The frame then looks about as in *D*, Fig. 4, and the subsequent operations cut more and more away from it until, in its practically finished state it looks like *F* and weighs but 4 ounces, nearly a pound having been cut away. But it is one solid piece of steel with no joint of any kind to give, with unpleasant, if not disastrous

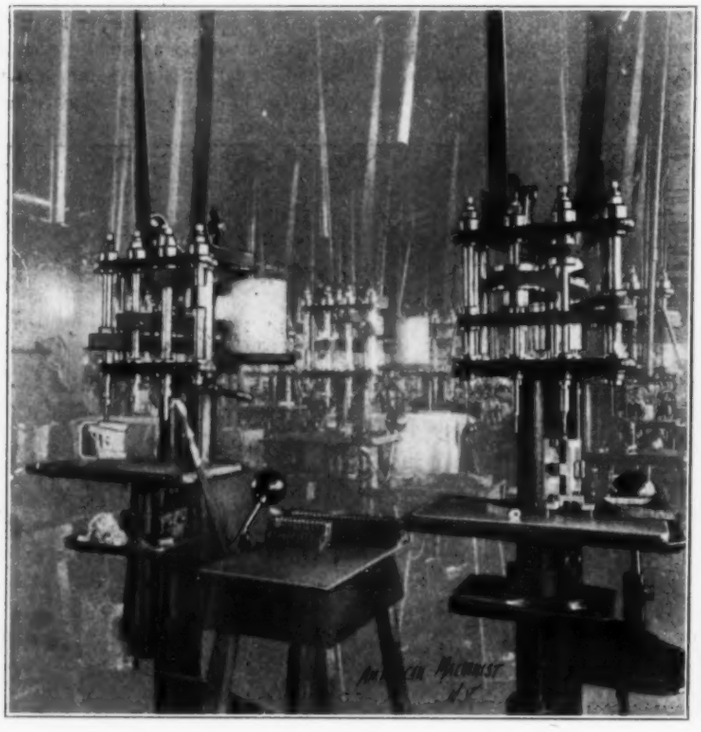


FIG. 7. ONE OF THE DRILLING MACHINES

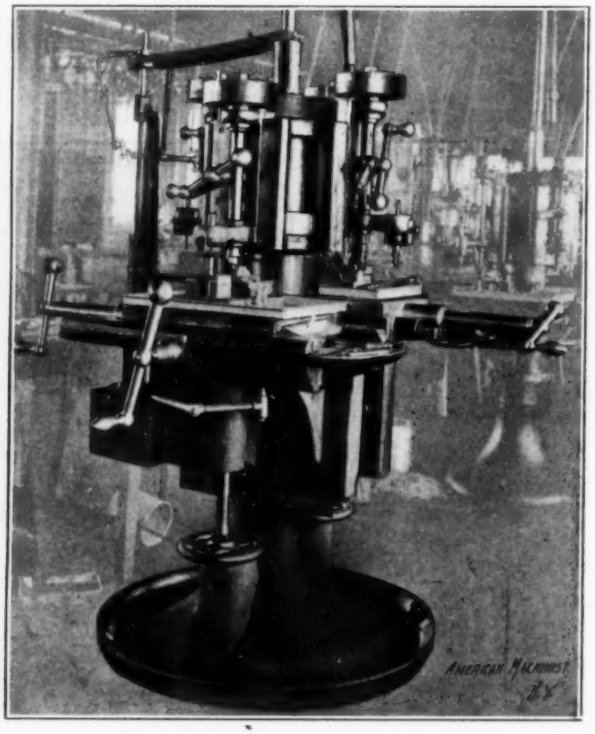


FIG. 8. A COLT DOUBLE-PROFILING MACHINE

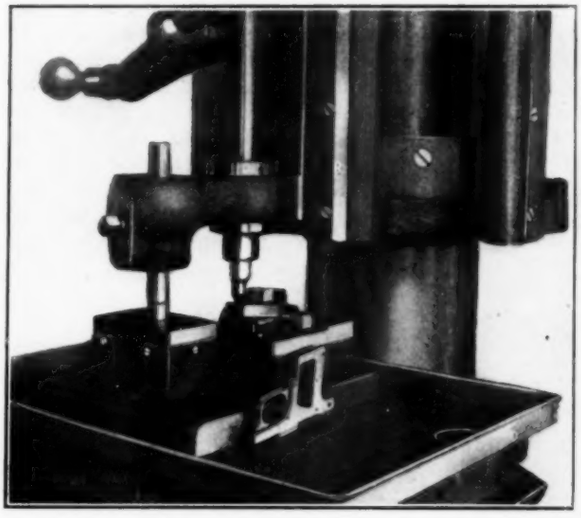


FIG. 9. DETAILS OF THE COLT PROFILER

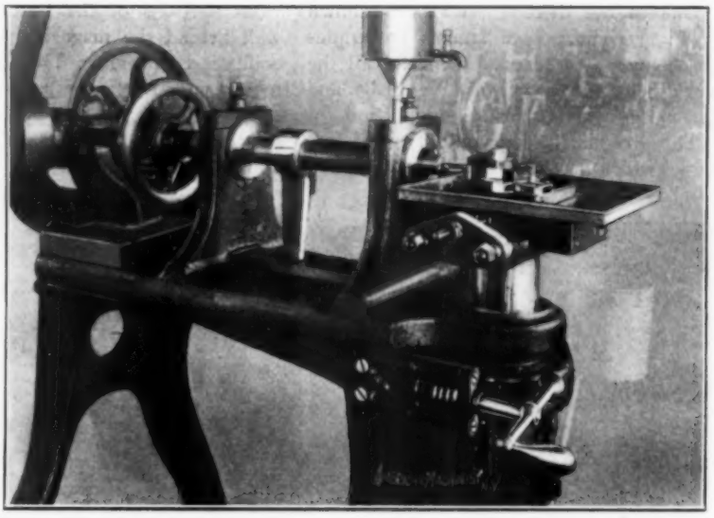


FIG. 10. HORIZONTAL SLOTTER OR PUNCH

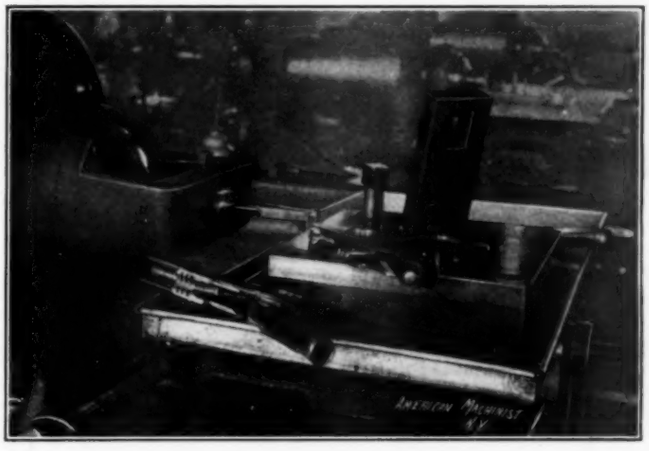


FIG. 11. A DIFFICULT MILLING JOB

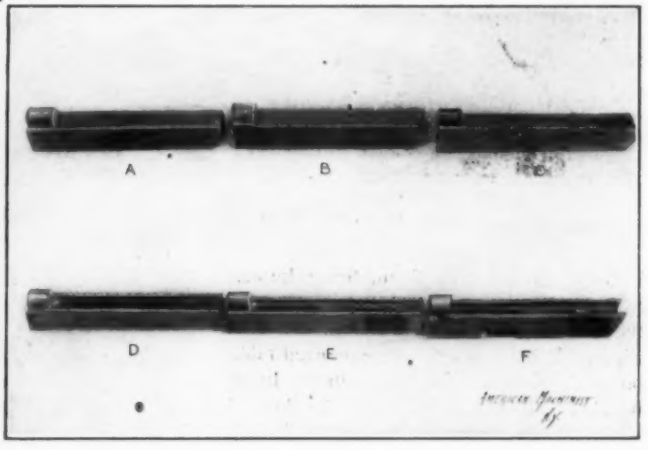


FIG. 12. THE SLIDE IN SIX STAGES

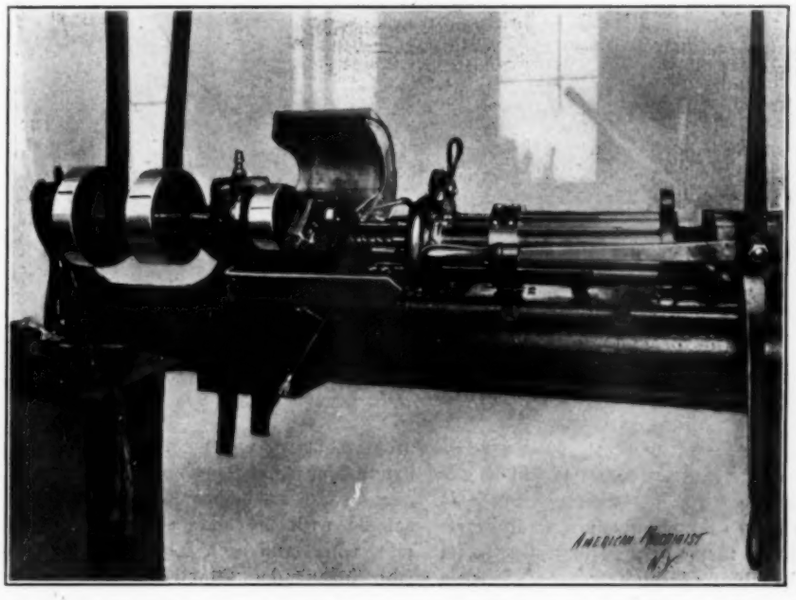
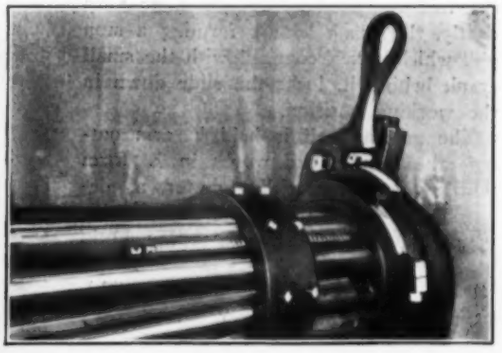


FIG. 13. TEN-SPINDLE CHUCKING LATHE



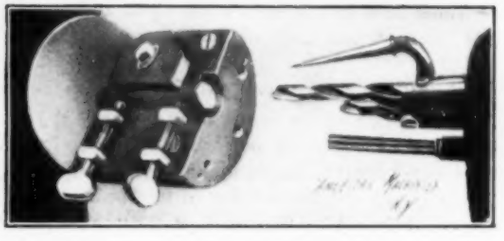


FIG. 14. THE TURRET LOCK
FIG. 15. DETAILS OF THE CHUCK

results, from the shock of firing its charge.

One of the drilling sections is shown in Fig. 7 where both frames and slides are being operated on, practically all the work being done by sensitive drills and the aid of jigs to insure duplication.

The profiling is done on a type of machine which has been developed here and driven back and forth and slots the various portions of the frame, leaving the wall behind the magazine very thin, but solid and straight. The work can be moved in any direction, back and forth, up and down and can be swung around by the worm and segment of a worm wheel on the column.

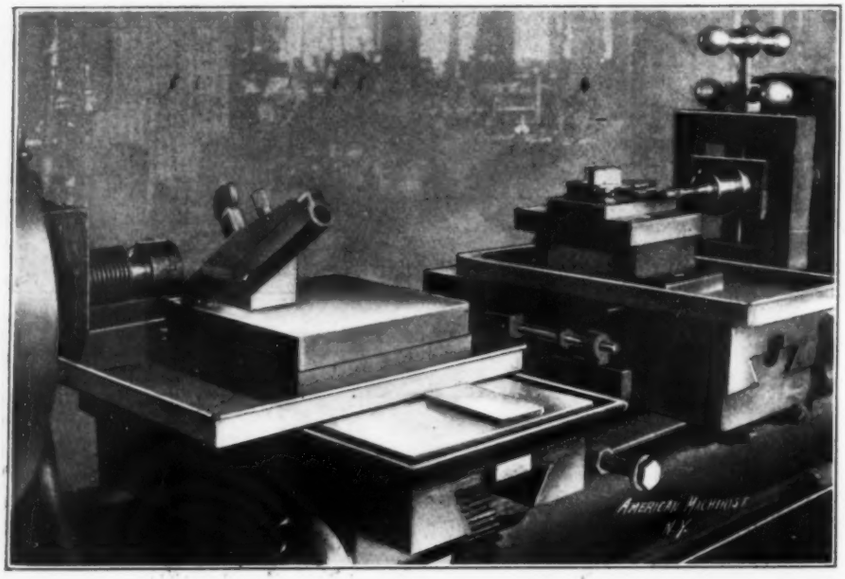


FIG. 16. TWO MILLING OPERATIONS ON THE SLIDE

is built specially for them, being known as the Colt profiling machine. One of these is shown in Fig. 8 and in detail in Fig. 9. It has a deep, well supported table on each side and a four-spindle head, which revolves so as to bring the desired spindle to the work on the table. Bringing the spindle-driving pulley down into contact with the main, central driving pulley, imparts the necessary motion to the milling spindle. This is done very neatly, the crank handle forming a stop pin, which, when engaged with the small crank behind it, locks the slide down in the working position.

The guiding roll is held in arm outside the spindle and works in a form which guides the milling cutter, as desired, to form the trigger guard in this case. The table has ample movement in all directions and enables a man to follow the form with very little difficulty. This is shown in detail in Fig. 9, which has a receiver in position and also one in front to show how it has been drilled out and cut away at this stage of the game.

A Punch or Horizontal Slotter

The slotting of the frame is an interesting operation and is performed on the horizontal slotter, shown in Fig. 10. This has a round spindle running in two bearings and driven by the crank at the rear. The stroke is fixed, but can be positioned, the same as a shaper ram, by the hand wheel at the rear. The work is held by the clamp in front, while the tool is

A Hard Place to Mill

One of the hardest places to mill is the slot for the trigger connector, which is a very light yoke affair, allowing the cartridge to go through it. This has to be let into the sides of the frame at an angle and requires a special milling fixture, as shown in Fig. 11. A special yoke is fitted onto the front of the milling machine, and carries a peculiar-shaped support for the special milling spindle with the small milling cutter solid on the end of it. The frame is clamped to the table by the leaf-jig arrangement shown, and the work fed against the cutter which is supported by the extension shown. It is a difficult job of milling, but this gets over it in good shape. The frame in front has the gage slipped into place for testing its size. Incidentally it may be interesting to note that there are 40 gages of one kind or another used on the frame alone.

The Slide

The slide is made from the same stock as the frame, comes ¾×⅞ inch in bars, and when it leaves the drop forger it is like *A*, Fig. 12, and weighs about 12 ounces. The milling operation comes first on machines exactly like those which handled the receivers, and they go to the 10-spindle chucking or horizontal turret lathes, as shown in Fig. 13. These have a peculiar form of chuck or half-chuck, practically an angle plate to which the work is fastened the same as to a milling-machine table. A guide in front supports the drill and insures its entering the work fairly and truly. This chuck requires counterbalancing, which is accomplished by the weighted pulley at the left of the cone pulley.

Each tool is in a separate spindle, sliding in proper supports under control of the long-handled pilot wheel, shown. A very ingenious locking device connects the upper spindle with the slide controlled by the pilot wheel and each spindle has its own stop, independent of all the rest. These are held, between the spindles, by the set screws shown in the band surrounding the spindles, just behind the handle of the pilot wheel.

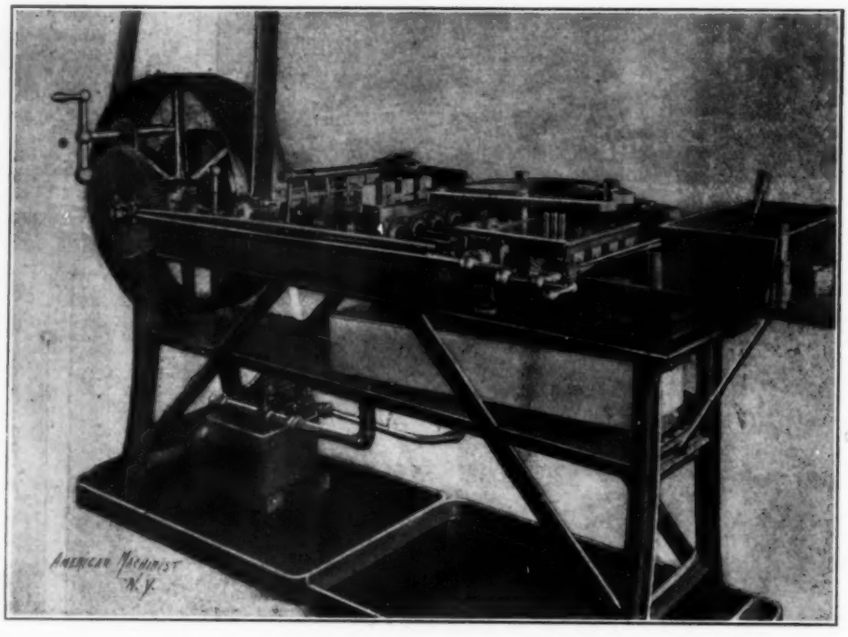


FIG. 17. RIFLING THE BARRELS

The indexing and locking feature is very ingenious, and together with the stops, are shown in Fig. 14. The locking pin *A* is lifted by the lower portion of the lever *B*, when the lever is thrown back to index the turret. This view is from the back, so that the lever is pulled toward the operator who stands in front of the machine. After the locking bolt is drawn, the other end of the lever engages a notch in the turret and brings the next spindle into place and it is locked by releasing the handle. As shown in Fig. 14 the locking bolt is withdrawn ready for the indexing.

In use, the sheet-metal oil shield covers the chuck and the work, the oil being supplied by the nozzle shown in the closer view of the chuck in Fig. 15. This shows a slide in place and the tools ready for work. It will also be seen that the tools are guided very firmly as near the work as possible, which is always to be desired.

FIG. 20. HOLDERS FOR DIPPING WORK IN SODA

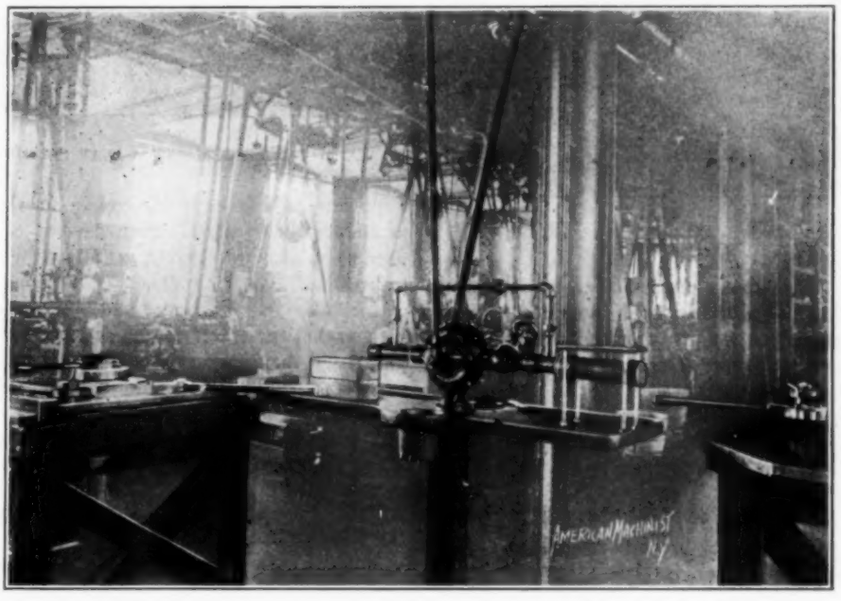


FIG. 18. THE FLAT SPRING DEPARTMENT

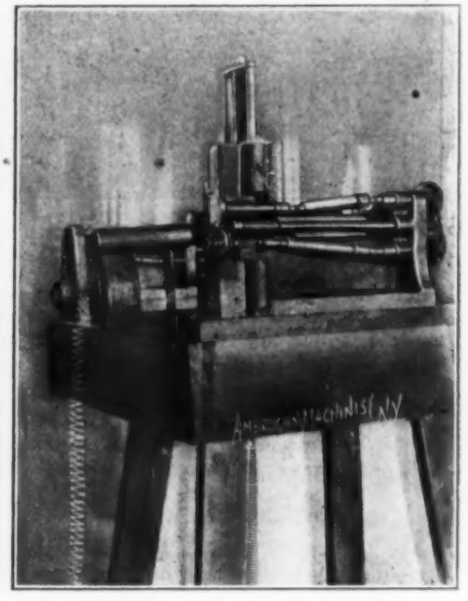


FIG. 19. WINDING MAGAZINE SPRINGS

Fig. 16 shows two of the milling operations on the slide, the first a cut on the side for the lock safety catch and the other cutting the grooves which hold the barrel in place in the slide. Both require special fixtures to insure duplication and rapid handling. The various operations would take too long to go into minute detail, but can be judged when it is known that 30 gages are necessary for the inspection of this one piece.

The Barrel

The barrel is largely a screw-machine job, being turned from stock 0.58 inch in diameter and having grooves on one end which fit into the slide. Most of these are afterward cut away on a milling machine to allow the barrel to be put into and taken out of place readily, as can be seen in one of the general views. The barrel weighs but 1¼ ounces when finished, less than half the weight of the bar stock from which it is made. It requires various reaming, including the chamber and other minor operations before it comes to the rifling machines shown in Fig. 17. These handle four barrels at once, the rifling tools being driven back and forth by the crank on the gear and the connecting rod shown, while the twist or rifling is secured by the slot *A* in the sort of quadrant which can be turned to different angles according to the pitch or rapidity of the twist. This forces a rack connection across the rifling spindles and turns them as the head moves back and forth. The rifling is only a few thousandths deep but it serves to twist the bullet enough to keep it true on its course. Then they are "leaded" or lapped to insure smoothness and accuracy in shooting.

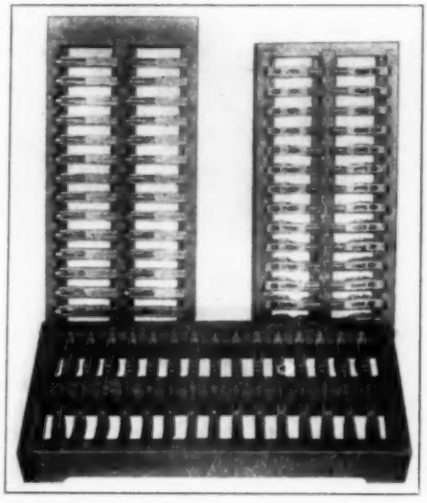


FIG. 21. RACKS FOR PISTOL PARTS

Making Springs

The spring-making corner as shown in Fig. 18 is interesting to anyone not familiar with this line of work. In the center is a double-ended heating arrangement consisting of a blower in the center, a firebricked heating forge or furnace at the left and a temper-drawing arrangement at the right. This is extremely convenient as it can be used by men on either side and serves both the spring-bending benches and tables. The spring bending itself is interesting but has no new features that call for illustration or description.

The magazines require a rather peculiar spring of flat section which is made on the machine shown in Fig. 19, which was designed specially for this work by Mr. Peard.

This is used to wind an oblong coil spring size from tempered-steel music wire of 0.041 inch diameter, and operates as follows:

First, the wire is put on the reel so that it will run free. It is then carried

through the feed rollers and engaged with the mandrel, the upper and lower rollers being set at the proper angle to give the spring the right pitch. The rollers have their bearings in movable slides, so that the oblong mandrel, as it rotates, can raise them to its highest point, from where they are forced back by heavy coil springs which keep the wire firmly against the mandrel, which gives the spring its shape. The slides also carry guides at the side of the rollers to assist them in forcing the spring off from the mandrel, which has two pivots at its end that at each one-half revolution of the mandrel receive a cam lever that is used to set each and every one-half coil of the spring as it progresses to the proper length.

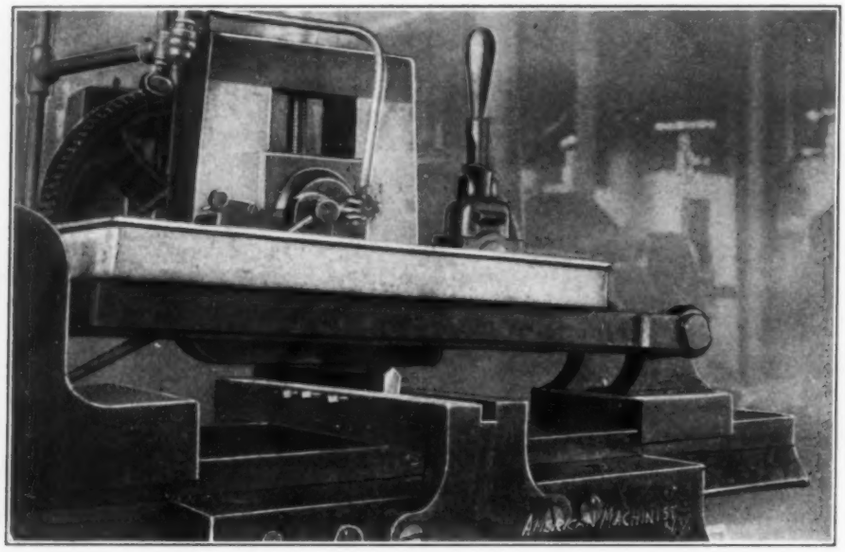


FIG. 22. A METHOD OF BRIDGE MILLING

Cleaning the Work with Soda

The soda tanks used in the Colt shop are permanent affairs, built into the floors, which are of brick. They come flush with the floor and are surrounded by iron floor plates and have a cover which is pulled out of the way when anything is to be dipped. The tank is piped from below, both for water and steam for heating and can be drained or filled without disturbing the workmen in the least. Two of the methods of dipping are shown in Fig. 20. The hook at the left is hung on the milling machine and the pieces, receivers or frames in this case, threaded on the long hook end so that they are ready for dipping without further trouble. The other rack is for slide and consists of concentric rings carrying pins over which the slides are slipped as they are bored after any other operation. Other styles are used to accommodate different-shaped pieces.

As in many classes of work similar to this the work is held in racks between operations and also carried from one place to another in this way. Fig. 21 shows some of these racks, for holding both frames and slides. This keeps them free from injury of any kind and also counts them almost automatically.

A Method of Profiling

One of the methods of bridge milling with a former is shown in Fig. 22, in which the former is under the milling machine work table and the fixed or guiding point directly under the milling-machine spindle. The form is attached to the under side of the upper or swinging table so that it, together with the work, moves up and down and carries the work with it. This is not a new method but not common outside of gun shops.

A somewhat similar method is to have formed slots or grooves cut in each side of the upper table and in these are grinding rollers which raise and lower the table as it moves back and forth under the milling cutter. Both accomplish the same results and each method has its advantages and objections.

Filing Jigs or Holders

Practically all of the pieces of a pistol, as in all gun work, have to be touched up with a file before finally going to the assemblers and many clever devices are used to hold them securely, yet allow them to be handled very rapidly. Fig. 23 shows a block clamped in the vise and fitted with pins so that the frame can be dropped into place and held securely, while all the necessary truing is being done. There is no clamping as the pins hold it and the pieces can be handled very rapidly. The other end of the block is arranged for another size of frame.

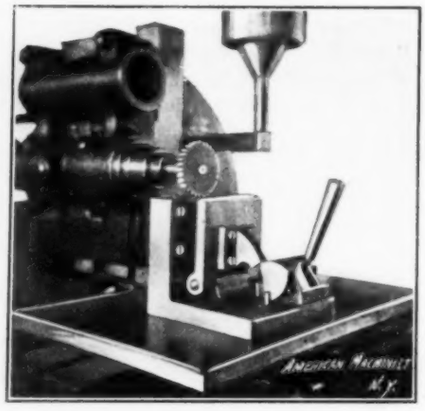


FIG. 26. A GOOD EXAMPLE OF A LEAF FIXTURE

In Fig. 24 the slides are being held in the wooden spring clamp, which is so very common in some shops and unknown in others. The pressure of the spring sides against the vise jaws hold the clamp in place, while the work is being changed so that it requires no handling except of the piece being filed.

Fig. 25 shows two filing blocks, one for the frame and the other for the slide. The former has a heavy base with an upright carrying a projection, which fits into the

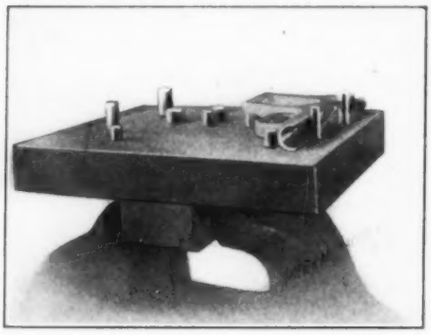


FIG. 23. PINE FILING HOLDER

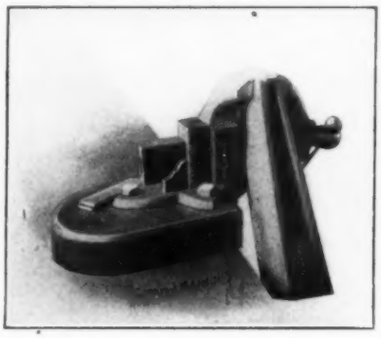


FIG. 24. CLAMP FILING HOLDER

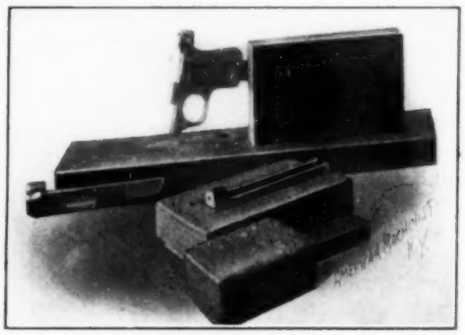


FIG. 25. CENTER FILING HOLDER

space to be occupied by the magazine when the pistol is finished. The frame can be put on either side up and touched up very easily while in position. In front of this is a lead block, shaped to hold a slide in much the same way that the vise clamp holds it, and is evidently another man's idea of doing the same job. The slide is simply laid in the groove and held lightly with the other hand while being finished.

A good example of a leaf fixture is shown in Fig. 26. The locking feature is the cam controlled by the lever at the right, which forces the leaf against the work through the curved or horn projection on the back of the leaf. When the cam is thrown back the horn can drop past it and let the leaf fall back and release the work. It makes a very substantial fixture and it will be noticed that the bearing or pivot pin is central with the clamping surface of the leaf.

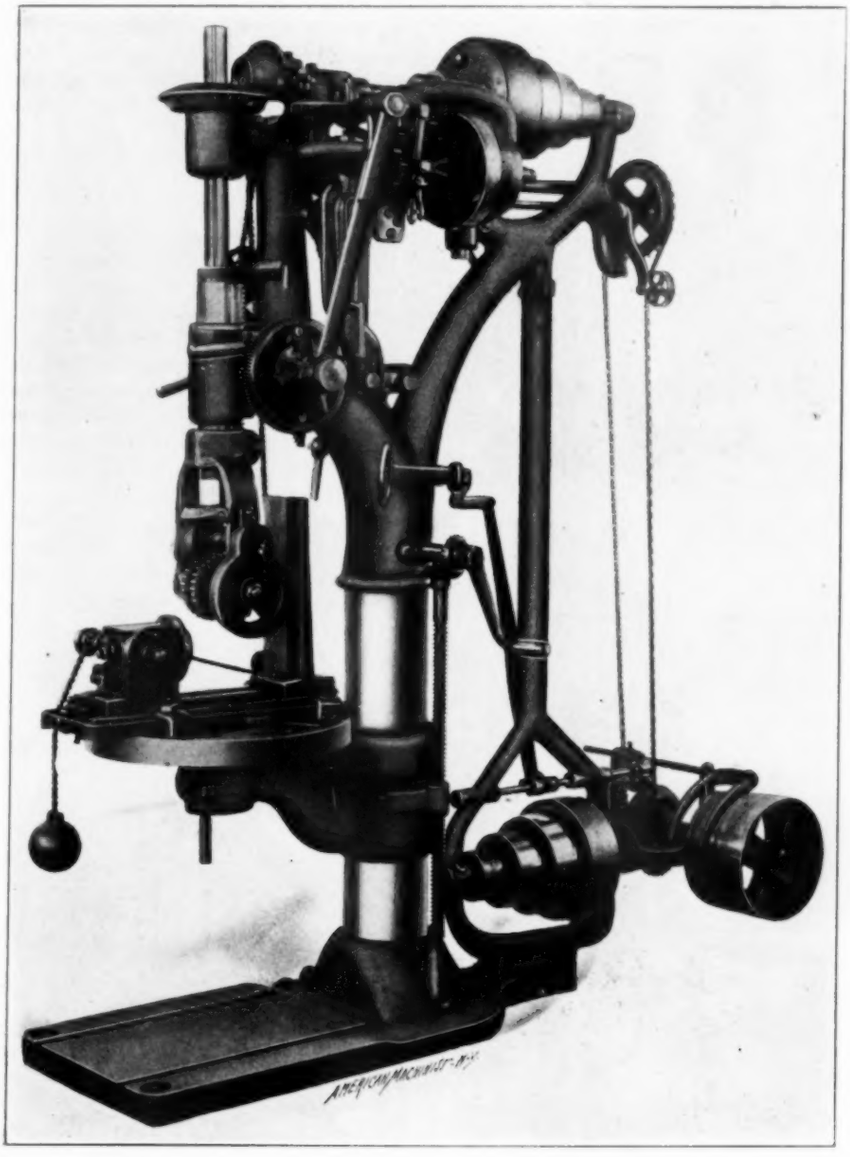


FIG. 1. MILLING ATTACHMENT FOR THE DRILL PRESS

Polishing and Bluing

After the machine work is finished, and the receivers and slides have passed inspection, they are sent to the polishing room and there given most careful attention to insure the perfect surface necessary for bluing to a degree that will be satisfactory.

The parts are thoroughly washed to remove dirt and grease, then covered with fine wood ash and placed in ovens, being repeatedly removed, rubbed with tow and whiting, and examined to see if the proper tint is brought out. When this has been obtained, the parts are then again cleansed, properly matched and sent to the assemblers for proper gaging, inspection, fitting and final assembling of the pistol complete.

The pistols are all numbered serially and after the parts are made, the stocks fitted to the receivers and the parts thoroughly cleansed for bluing, they are given over to this department. Then another cleaning is necessary and the entire pistol is assembled and tested by actual shooting, after which it is again cleaned, oiled, finally inspected and is then ready for the market.

F. H. C.

Attachments for Drill Presses

Editorial Correspondence

Many attachments are being developed for the drill press that increase its efficiency and widen its field of usefulness; thus the drill press of today is a much more complicated machine than it was some years back. These attachments have made it possible to do a great variety of machine work on the drill press, and, therefore, have made this tool a very valuable one for the machine shop.

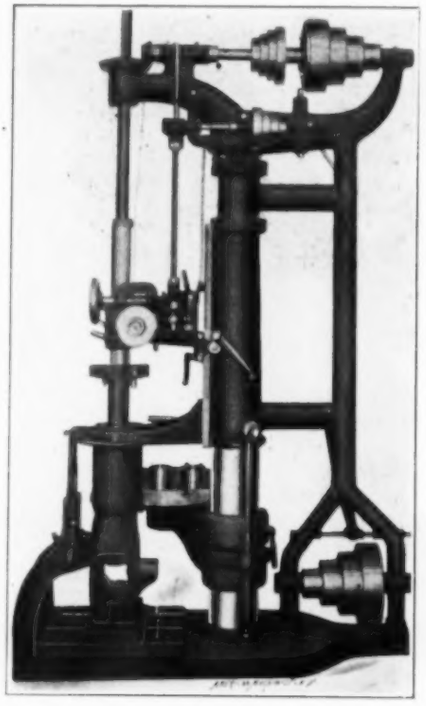


FIG. 2. ATTACHMENT FOR BORING CYLINDERS ON THE DRILL PRESS

The milling attachment shown in Fig. 1 is made by the Rockford Drill Company, Rockford, Ill., as are also the other attachments shown herewith. This attachment, it will be seen, is made in two parts. One part is fastened to the drill-press table and holds the work, as well as guides the cutter in its movements up and down. The other part fits around the spindle of the drill press and holds the cutter, the cutter being made to revolve by means of bevel and spur gears.

This attachment is easily set up, and with it all kinds of small work can be milled. A large variety of shapes can be

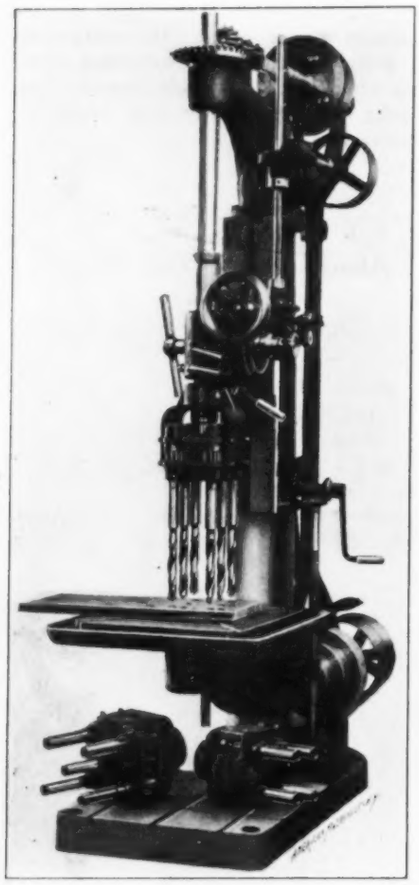


FIG. 3. MULTIPLE-SPINDLE ATTACHMENT

milled on it, as cutters can be made to correspond to the shape desired.

In Fig. 2 is shown an attachment for boring cylinders. With this attachment the drill-press table is swung out of the way and the cylinder is stood up on the bed plate of the drill. It is held in position by a casting that is bolted to the end of the bed plate and fits against the side of the cylinder, which is clamped to it. Another casting is clamped to the base of the column, at the right hight to fit around the top of the cylinder, and in this is placed three set screws that press against the side of the cylinder and hold it secure while it is being bored. The boring bar is then attached to the spindle of the drill, and the cylinder is bored as easily as by any other method.

A multiple-spindle attachment that can be attached to the ordinary spindle of drill presses is shown in Fig. 3. This attachment can be made to contain any number of drill spindles desired up to the capacity of the machine. The one attached to the drill contains six spindles, while on the bed of the drill is shown two other attachments, of five and four spindles each.

In Fig. 4 is shown a similar attachment with three spindles in a row. This drill press is set up with a jig for guiding the drills while drilling the three holes in the piece shown.

A very convenient attachment for drilling a number of holes, simultaneously, in a straight line is shown in Fig. 5. In this attachment the drill spindles shown are movable, back and forth, in a slot to any position desired, and fastened there and the intermediate gears between them are brought into mesh and fastened, which sets the spindles ready for work. Any number of drill spindles up to the capacity

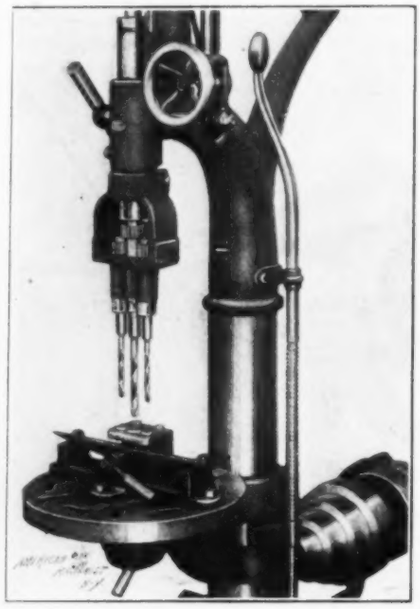


FIG. 4. THREE-SPINDLE ATTACHMENT

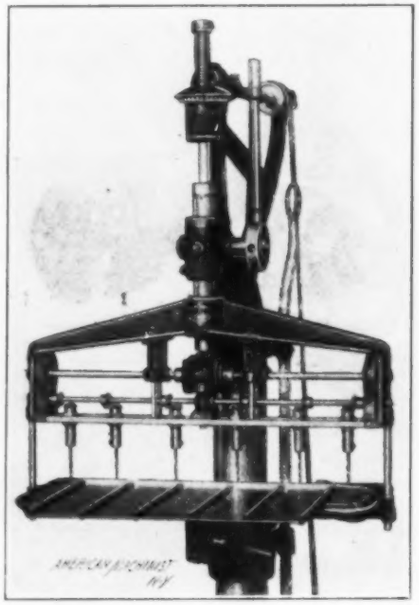


FIG. 6. ATTACHMENT WITH SIX SPINDLES MOVABLE IN A STRAIGHT LINE

of the attachment, or that the drill press will drive, can be used in this.

Another attachment, in which the spindles can be moved back and forth is shown in Fig. 6. In this the spindles are moved in a slot and clamped when in the desired position. On top of each spindle is a bevel gear and another bevel gear, that runs on the shaft above the spindles, is brought into mesh with this one and clamped there. This rod is revolved by gears, that are located on each end of it and the rod above it. The upper shaft is run by bevel gears, which are on it and the spindle of the drill press.

This attachment can be used on quite small drill presses, and while the attachment shown has six spindles, any number of spindles can be used that is desired, providing the drill press has power enough to operate the drills.

These are some of the more important attachments which the Rockford Drill Company have applied to their drill presses in order to increase the scope of their work, and others are being brought out from day to day for the special jobs performed by users of their drills.

From an article in the *Engineering Magazine*, dealing with the heating equipment, it may be asserted that it is possible to obtain a degree of regulation with steam by varying the pressure; but the best results obtainable by such a method depend on the use of high-pressure steam direct from the boiler, and even then it is not advisable to use a greater pressure than 30 pounds in cast-iron radiators. This would give an increase in the temperature of the steam from 212 degrees to 274 degrees, and if exhaust steam is used, would involve the increase of the back pressure on the engines.

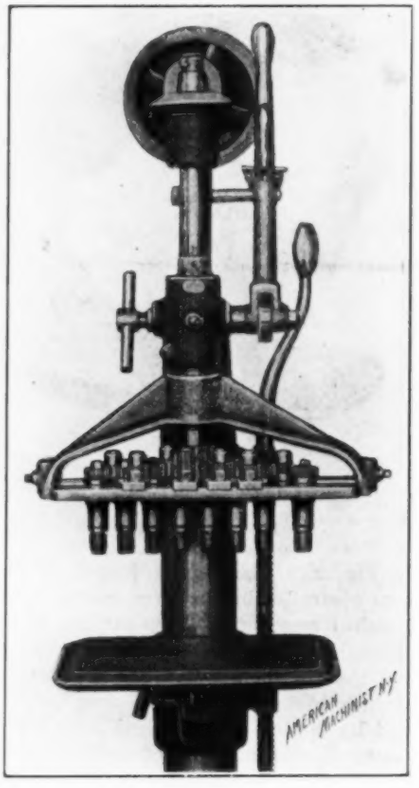


FIG. 5. ATTACHMENT WITH EIGHT SPINDLES MOVABLE IN A STRAIGHT LINE

The Panama, a Machine Made Canal

Some of the Machines That Are "Making the Dirt Fly" on Uncle Sam's Ditch across the Isthmus. Comparisons with Hand Labor

SPECIAL CORRESPONDENCE

One hundred and eighty-two million cubic yards of earth and rock to be excavated and carried away by machinery. This is the figure which is given by the engineers in their estimate of the total amount of excavation required to construct the Panama canal.

If the canal were laid out in the shape of a city street fifty feet wide between house walls and lined on both sides with a solid row of block houses three stories, say 40 feet high, this street would extend for 465 miles, or 25 miles further than from New York to Buffalo, by way of the New York Central railroad. If the canal were to be constructed in the shape of a city water main, three feet in diameter, this pipe would be 131,600 miles long and could be wrapped around the equator of the earth just about five and a quarter times.

It is machinery that is building the Panama canal. In all the more than twenty years of French occupation there was accomplished only 40,000,000 cubic yards of excavation that is available for the present canal. In spite of the small amount of work done during that time, our engineers have only praise to offer for the work which the French did, considering the tremendous handicaps under which they labored. The French used machinery, but it was largely the machinery of 20 or more years ago and although of usually first-class quality, it was not capable of the wonderful performances of the modern machinery with which our engineers are most plentifully supplied. Here is a list of some of the equipment now in use at Panama: 293 locomotives, 100 steam shovels, 30 Lidgerwood unloaders, 24 spreaders for disposing of the unloaded material, 3608 railroad cars of various types, 5 suction dredges, 5 ladder or chain bucket dredges and two dipper dredges, twelve in all. Besides these major items, there are large numbers of excavating machines, cranes, derricks and hoisting and conveying apparatus.

Of the French machinery, there is considerable available and now in use. Among these are several dredges, especially of the ladder type, quite a number of excavating and drilling machines, locomotives, barges and other items, which, being of first-class construction and being very carefully put away and protected by paint and grease from the action of the weather, have been found in excellent condition. Some of the old French dredges were found up among the trees of the jungle, raised considerably above the old level of the French canal by the deposit of silt under them from the action of the water in the old canal and the rivers in which they were anchored.

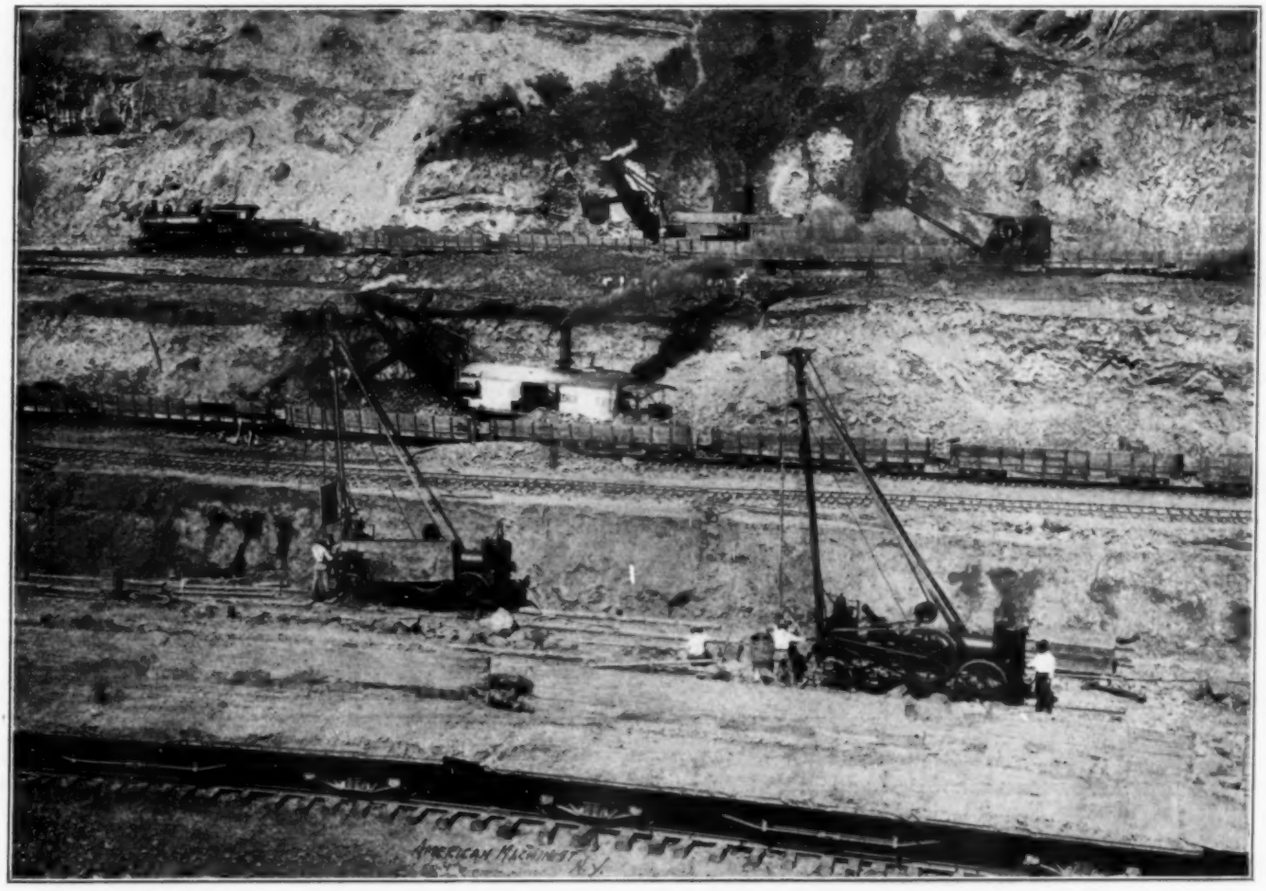


FIG. 1. THE DIFFERENT BENCHES AT THE CULEBRA CUT

Machine Work versus Hand Work

D. W. Bolich, a former division engineer at Culebra presented some interesting comparisons a short time ago to show

what the machinery is doing in comparison with the number of men that would be required to do the same amount of work. These data appeared in the *Canal Record* for August, 1908, and the following figures are taken from the remarks of Mr. Bolich.

At a time (March, 1908) when there were 44 steam shovels in operation, each averaging 18,600 cubic yards per month or 744 cubic yards per shovel per day, Mr. Bolich figures that it would have required 5456 laborers to do this work. The number of men employed in and about the shovels for operating them and for clearing the track and moving the shovels up to their work, including foremen, was 208, which would be just about the number of foremen which would be necessary to handle the 5456 laborers who would be required to do the work of the 44 steam shovels by hand.

This is not the whole showing of the steam shovel, for a man will handle a rock weighing from 150 to 200 pounds while the steam shovel will handle rocks weighing 21,000 pounds. Mr. Bolich deduces from this comparison that with hand shoveling, owing to the smaller size of rock which a man could lift, it would be necessary to do twice or three times as much drilling and blasting as is now done for breaking up the rock to be handled by the shovels. At the time under consideration there were 700 to 800 men engaged in drilling and blasting which Mr. Bolich estimates would have to be increased to from 2100 to 2400 men to break up the same material to be handled by manual labor. During that time there were 260,000 pounds of explosives used in the month, that is, March, 1908, and, if the loading had been done by hand,

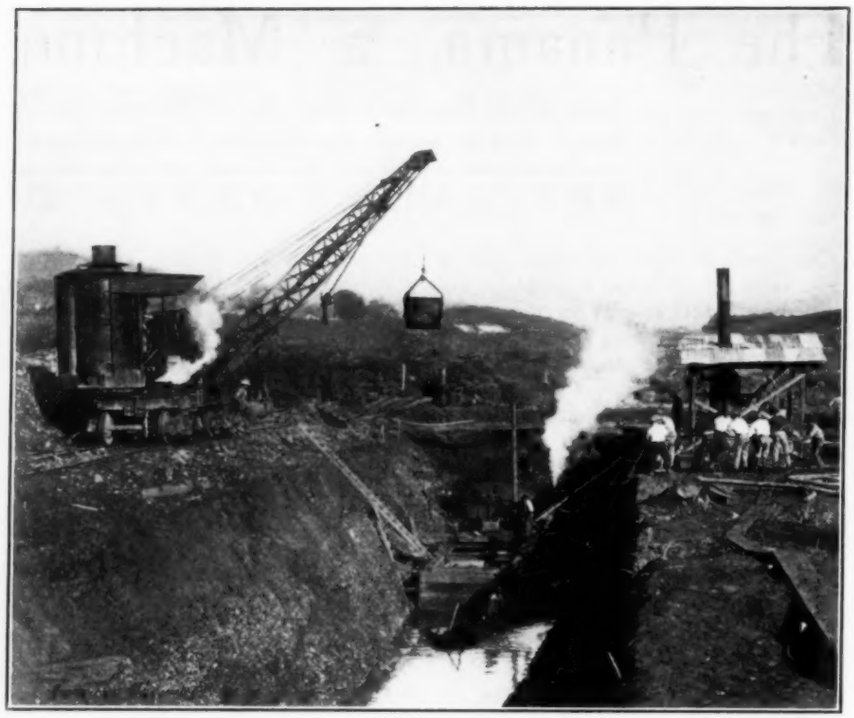


FIG. 3. EXCAVATION FOR CORE OF MIRAFLORES DAM

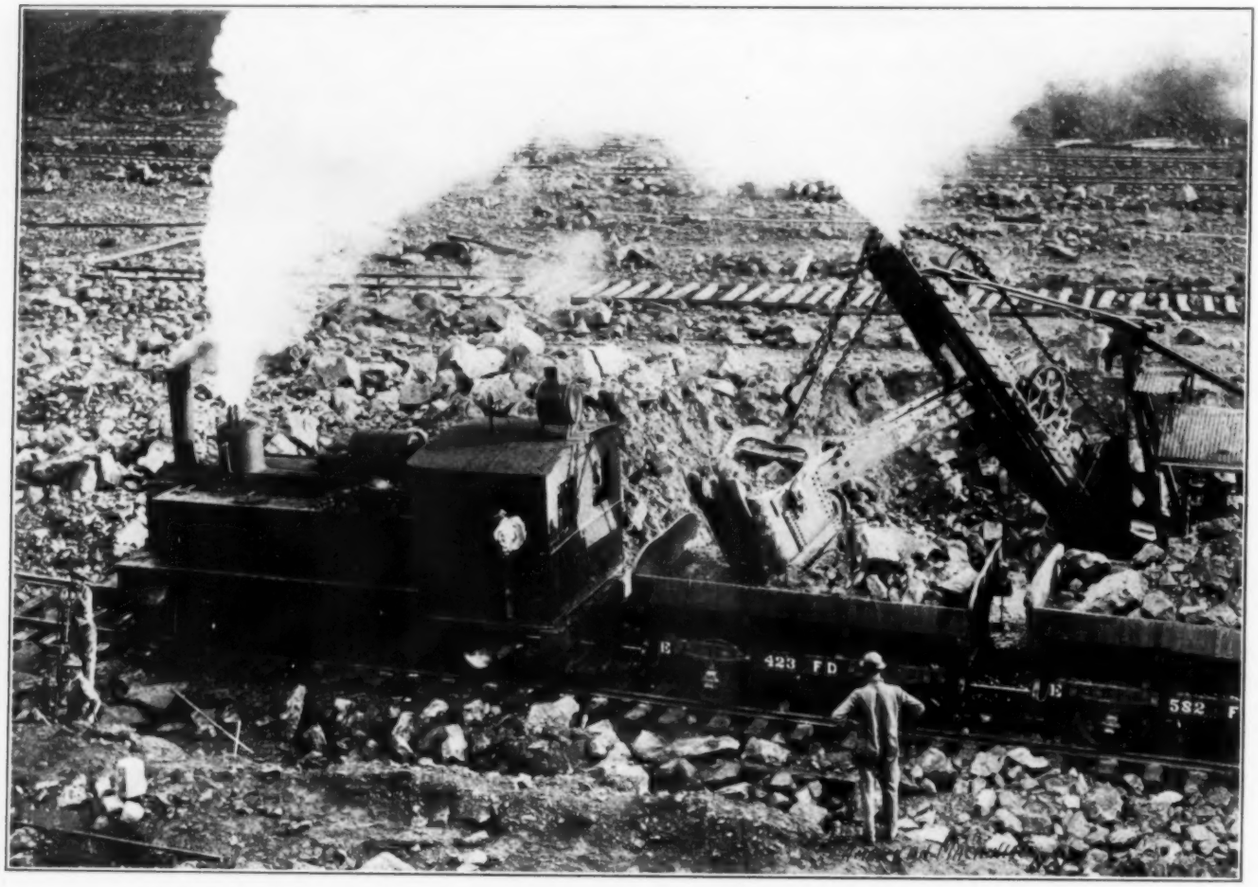


FIG. 2. AN AMERICAN STEAM SHOVEL WITH A FRENCH LOCOMOTIVE AND CARS AT MIRAFLORES LOCKSITE

necessitating the extra drillers and blasters, they would have used about 780,000 pounds or more of explosives to do the same amount of work.

Under the subject of track moving at the dump where it is continually necessary to move the track nearer and nearer the edge of the dump as the material is thrown over, one crane, used for shifting the track and which will throw a little over a mile of track 9 feet in eight hours, represents the work of 500 to 600 men in the same time. The machine is handled by nine men, three whites and six ordinary laborers. Mr. Bolich again estimates that the nine men operating the machine would be just about enough foremen to handle the 500 or 600 men who would be required to move the track by hand.

As to unloading the long trains of dirt cars and shoving the material over the dump, which is now done by the unloading machines and spreaders, seven unloading machines, requiring 28 white men and 42 laborers and firemen, could handle the March output, and it is estimated that to do an equal amount of work by hand would require 2660 laborers. As to the spreaders, for pushing material over the dump after the cars are unloaded, Mr. Bolich estimates that the eight machines, with 16 white men and 24 laborers and firemen, which were in use at the time he made the estimate, were doing the work of at least 3000 laborers.

FIG. 5. THE SPREADER LEVELING OFF A DUMP

Comparing the sizes of the cars and locomotives used by the French and by the American engineers, Mr. Bolich estimates

FIG. 4. THE LIDGERWOOD UNLOADING SYSTEM

that to remove the daily output of 32,000 cu.yd. it would take 666 French trains to do the work of 133 American trains using Western dump cars, or 104 American trains of flat cars with the unloading and spreading machines.

The Doctor's Part

So much for machine work as compared to hand work. While it is undoubtedly true that modern machinery is making a tremendous record, it must also be remembered that the question of sanitation is of the very first importance. It was not until the Spanish war developed the sanitary methods of the United States army surgeons that the ordinary white man could live in such a country as Panama. This is a triumph of medical science and while the engineer may be justly proud that modern mechanical devices which he has invented are making the excavation of the canal possible, at least an equal if not a greater share of the praise should go to the medical man who has made it possible for the white engineer to live in the country where his machinery is doing such successful work.

Before any large number of men could even be brought to the isthmus, it was necessary either to eliminate yellow fever or to find a large foreign population which was immune to this disease and which could be drawn upon for laborers. Had the old condition of sanitary and medical knowledge still prevailed as in the days of the French company, it is very doubtful even with modern machinery, if the canal would ever have been finished, in spite of the enormous resources of the United States behind the work. The awful loss of human life which must have taken place would sooner or later have raised a protest of revolt in the United States which would have imperiled the work. This work of sanitation naturally caused considerable delay in the actual work of excavating the canal, for the Government had a tremendous problem upon its hands of drainage, sewers, model streets, model houses, perfect plumbing and an extensive treatment throughout the greater part of the Canal Zone to eliminate the mosquito.

The Government had to build model cities for the occupancy of the thousands of skilled and unskilled men to be employed. This involved also the provision of commissary stores for their supplies, quarters for wives and children, and school houses and teachers for the children. There is no doubt that this providing for the wives and children of the men working on the canal is a most potent factor in the success of the work. It is really wonderful to think of the foresight of the men who had the planning to do and who thus looked after not only the health and feeding of the men, but actual home comforts such as they would have had in their own country.

A New Panama Railroad

Another obstacle to quickly getting at the work of excavation was the fact that the Panama railroad was only a single-track line and absolutely incapable of carrying the vast quantity of freight, machinery, stores, etc., which had to be carried into the Canal Zone. This railroad was single track, running from Colon to Panama, approximately a distance of between 40 and 50 miles. As the material and supplies began to arrive in large quantities, it was but a short time before this road was completely tied up and overwhelmed with freight to be transported. To overcome this the Panama railroad has been practically rebuilt in an entirely new location and with double tracks. The new location was necessary because a large portion of the road would have been under water after the canal was finished if left in its old position.

Emphasis has been laid on the fact that the work is being done by machinery, and that vast quantities of work are being done. The removal of the material from the ground in a given time is simply a question of putting in enough machines to dig it out; in other words, a matter of equipment. There was, however, another problem of very serious proportions which

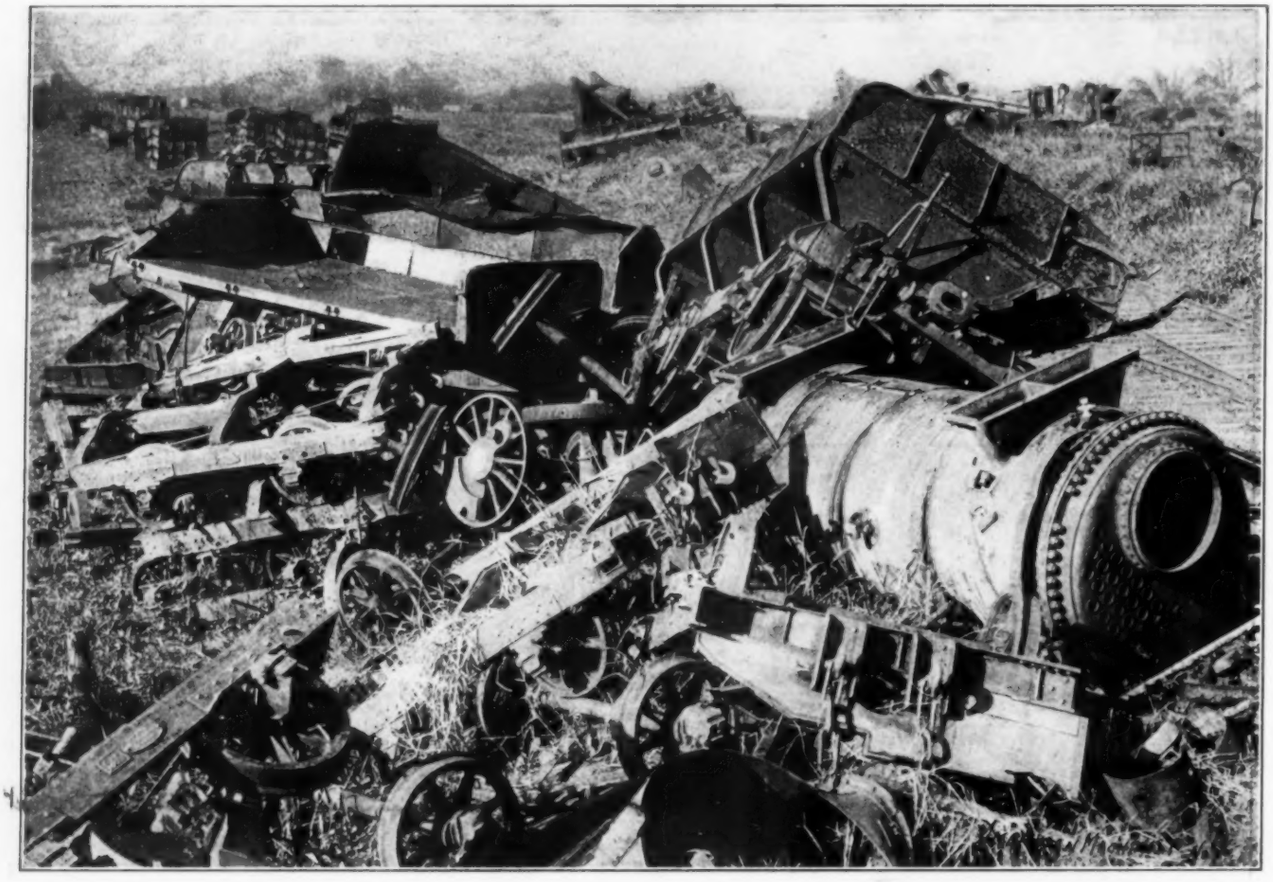


FIG. 6. A FRENCH MACHINERY GRAVEYARD

had to be faced by the engineers, namely, the matter of getting rid of the material after it is dug out of the ground, and the rebuilding and relocating of the Panama railroad was arranged to facilitate this in every possible way.

All along the railroad positions were selected for dumping the material which had to be gotten rid of as fast as it was excavated. There were 25 main dumping places arranged where vast quantities of material could be disposed of and numerous other smaller locations which are not dignified by name. The largest of the main dumps is that at LaBoca where it was estimated that 24,820,000 cubic yards of material could be disposed of. The next largest was that at Tabernilla. Here it was possible to get rid of 13,377,000 cubic yards of material. At Miraflores there was space for 11,750,000 cubic yards. At various points along the new Panama railroad there was filling to be done which would take care of about 7,630,000 cubic yards. At numerous other places about 5,000,000 cubic yards could be disposed of and at the smaller unnamed dumps nearly 7,000,000 cubic yards could be taken care of. It is estimated that the total dumping space would dispose of about 95,850,000 cubic yards of earth and rock.

It must be remembered that it is usually possible to dump only one train at a time at any one dump and while, as has been shown, the rate of excavation could be indefinitely increased simply by the addition of more excavating machinery, it became absolutely necessary to use machinery for unloading the trains as well as for loading them. Also the earth

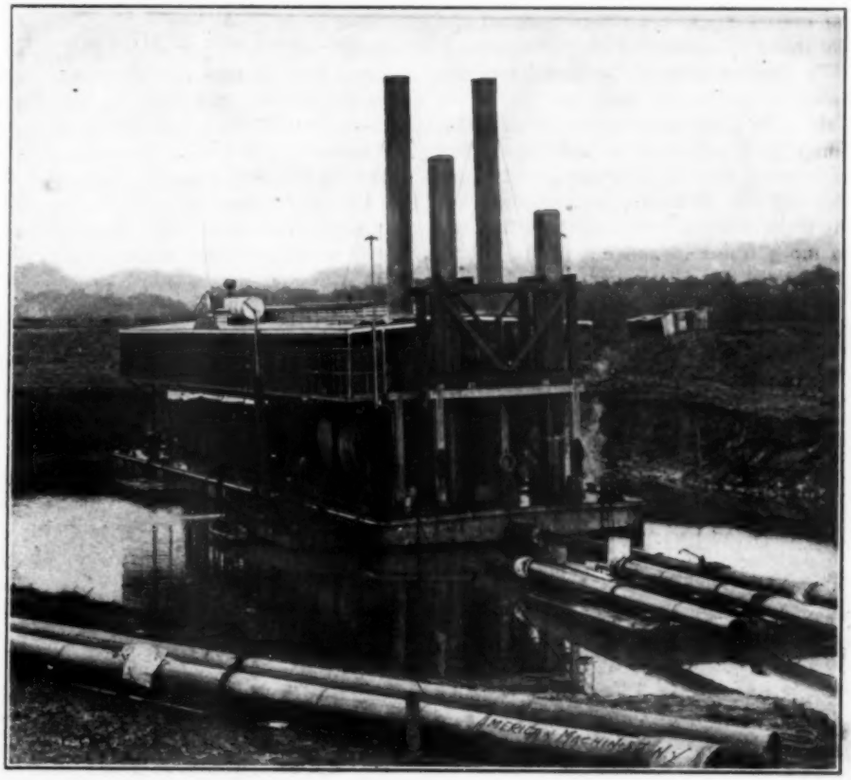


FIG. 8. THE SUCTION DREDGE "SANDPIPER" EXCAVATING IN LOWER LOCK AT MIRAFLORES

FIG. 7. CLEANING THE TEETH OF THE "SANDPIPER" DREDGE

dumped over the embankment had to be leveled off and then at frequent intervals the tracks would have to be shifted over toward the edge of the dump as it receded. All of this work is done by machinery and this machinery plays as important a part in the work as that doing the direct excavating.

Unloading Seventeen Cars in Three Minutes

To unload the long trains of flat cars, the Lidgerwood rapid unloader system was adopted. This system consists of a powerful geared winding engine mounted on a car next to the locomotive and taking steam to operate it from the locomotive boiler. The engines are made in two sizes, one capable of exerting a pull of 25 tons on its cable and the other capable of exerting a pull of 60 tons. The cable from the drum reaches away to the end of the loaded train where it is attached to a plow on the last car. When the engine is started it draws the plow through the whole length of the train sweeping the entire load off a train of 16 or 17 cars in three minutes. The load may be deposited on either one or both sides of the train at once, according to whether the plow is right-handed, left-handed, or double-faced. In the case of the Isthmian canal, the plows deposit the earth on the side of the train next to the slope of the dump. The cars used for this system are known as Lidgerwood flats. They are the ordinary flat car with no modification except that a sheet-steel apron is attached to one end of each car in such a manner that it can be thrown over across the gap between the cars thus making a continuous surface for the plow to pass over from one end of the train to the other.

In order to stretch out the cable from the winding car to the last car, upon which the plow is located, the train passes under a gallows frame, to which the end of the cable is attached. By pulling the train along the track by means of its locomotive the cable is thus drawn out and laid along the top of the piles of earth on the flat cars. When the last car containing the plow passes under the gallows frame, the cable is unhooked from the frame, dropped down and attached to the

plow. After this by the winding in of the cable by means of the winding engine, the plow traverses the train sweeping the earth from the cars as described.

The Isthmian Canal Commission has 20 of the 60-ton size unloaders and four of the 25-ton size and nearly 1800 Lidgerwood flats on the central division. Each car carries 20 cubic yards of material and the trains usually consist of 17 cars each.

To give an idea of the capacity of the unloader system, the daily records of the Tabernilla dump may be taken. At this dump four unloaders unload an average of between 50 and 54 trains per day and this capacity is limited by the ability of the train crews and the switching facilities to move trains in and out of the siding. The plows in operation are guided by the stakes along the side of the cars. As the material handled from the Culebra cut often consists of large pieces of rock, the stakes are left out on the side of the car toward the dump and the plow is guided by those on the opposite side. With this arrangement, the unloader will unload anything which a steam shovel can load on a car and there is none of the delay experienced on the work with all dump cars where large pieces get wedged between the floor of the car and side doors, often necessitating the use of dynamite to dislodge, with consequent damage to cars and, what is much more important, the serious delay of the whole train.

Whenever the spoil piles up beside the track to such a hight as to threaten interference with the car, a leveler is drawn over the track by a locomotive. By means of a wing swinging out at an angle, this leveler sweeps the earth over the edge of the slope, leaving a level space between the track and the slope. The handling of the wing for the leveling is done by means of special machinery on the car, some of the operations being performed by compressed air.

Shifting Track by Machinery

From time to time the track is shifted over toward the new edge of the slope. Ordinarily, the track shifting is done by the unloaders which have a side sheave provided for side pulling. One end of the cable is attached to the track, the cable is passed through a block attached to a "dead man" and the engine slides the track sideways section by section, the track bending to accommodate the movement. To make this operation more expeditious, the engineers of the Canal Commission designed and had built a number of track movers of a novel type. These are car cranes or derricks. With a fall attached to the end of the boom they pick up the track and by swinging the boom bend over a section and deposit it in its new position and this operation is repeated again and again as the crane is moved backward along the track.

Dredging

At the lower levels of the canal at the sea ends the excavating in the canal prism is being done by dredges. Some of these are of the chain-bucket type, some dipper dredges and some hydraulic-suction dredges. Several of these machines of the chain-bucket type date back to the days of the French company, and one of these, the "Gopher," is a record holder for capacity. The chain-bucket or ladder type of dredge employs a continuous chain carrying a large number of steel buckets not unlike a conveyer. This continuous chain travels over sheaves mounted on a heavy structural steel frame work which is designed to push the bottom end down against the material to be excavated as the chains revolve, carrying the buckets round and round.

The dipper dredges are not greatly different from the steam shovels except that they are mounted on barges instead of railroad cars and are designed for a deeper and greater radius of action.

The suction dredges are used where the material is of such a character that it can be pumped by centrifugal pumps. These dredges often have the end of the suction pipe which digs into the material equipped with a rotating cutter, driven by a separate engine, so as to cut up the material and facilitate its being drawn into the pipe. Several of these suction dredges are of the sea-going type, and their appearance is not greatly different from that of a medium-sized steamer with the exception that there are the long suction pipes along their sides which may be dropped down into the water to rest on the bottom. These pipes are connected to the side of the ship by means of swinging elbows.

The sea-going dredges also carry all the material which they excavate; that is, they do not use a separate barge which,

FIG. 9. OLD FRENCH LADDER DREDGES AT CHRISTOBAL

owing to the rough water, might be in danger of continually battering the side of the dredge. When the dredge has taken on all the material which it can handle, it steams out by its own power into the ocean several miles and there dumps the material. This method of disposing of the material greatly simplifies the problem which is solved on land by the unloaders and spreaders. Those dredges which are not sea-going, of course, dump into barges and the barges are towed out to sea and there dumped.

The suction dredges are not so popular with the general public because they attend strictly to their own business, and, while making no fuss or noise, are eating away millions of cubic yards of earth below the water, at a rate to put to shame

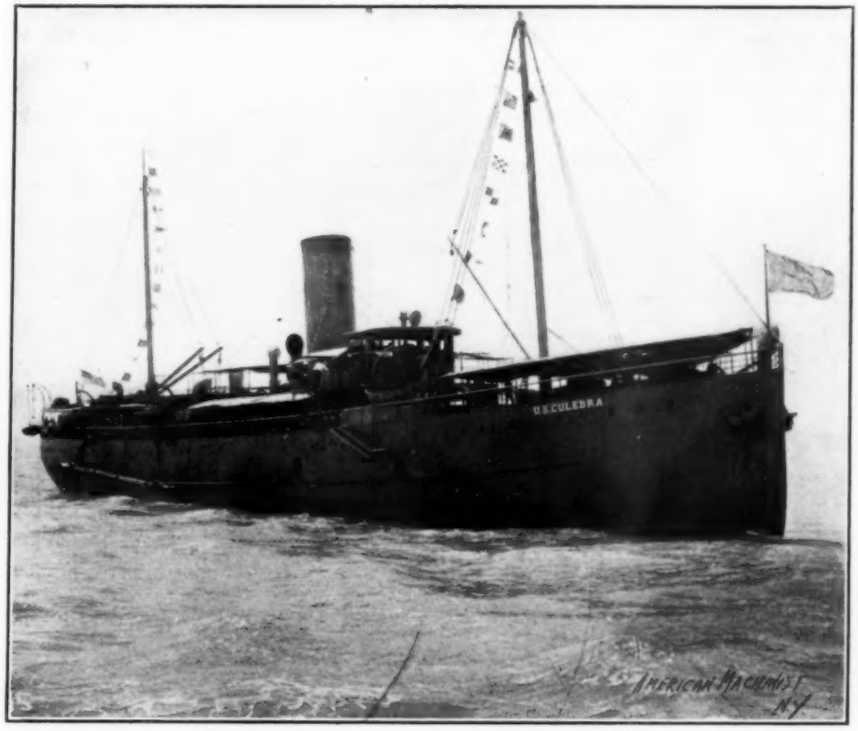


FIG. 10. SEAGOING SUCTION DREDGE "CULEBRA"

the spectacular steam shovel with its racket and bustle and rattle.

The Great Cableways

Another most important feature of the work on the canal is the construction of the Gatun dam and locks. These in point of time are the controlling feature of the work. The excavating of the canal will, in all probability be finished in August, 1911. There are now only 101,000,000 cubic yards to be taken out, and this is going at the rate of nearly 4,000,000 cubic yards per month. If necessary this work could be expedited, as has been pointed out, by putting in a larger plant.

The situation in regard to building the Gatun Dam and locks is, however, entirely different. These will be the controlling feature in fixing the date of the finishing and opening of the canal. The dam will be a great earth and concrete embankment and the filling and settling of this mass of material will take time and cannot be hurried. The building of the locks is one of the largest undertakings of its kind ever designed. There will be a double flight of three locks, each lock having an inside length of 1000 feet and a clear width of 110 feet. Each will have a depth of 30 feet giving a total available lift for the flight of 85 feet. For the building of the locks there has been designed and provided by the Isthmian-canal engineers the most elaborate installation of machinery ever conceived for such a purpose. It is designed to give the highest possible speed and efficiency and to so completely cover the work as to make it a virtual impossibility for any greater expedition to be secured by any possible means.

The machinery to be used for building the Gatun locks consists of 13 high-speed electrically operated Lidgerwood cableways, all with traveling towers and so arranged as to allow of the control of their operations from any convenient point. These cableways are in two groups, one group for unloading concrete materials and putting them in storage in the mixing yard, the other set is for the actual work of building the lock walls. The materials for the locks will be taken to Gatun by vessel. There is at that point a portion of the old French canal which runs alongside the new site and opposite the lock site. This has been cleaned out and rendered available for receiving the material-laden barges.

Spanning the canal at this point and reaching across to the adjoining ground toward the locks for a total distance of 800 feet, are the unloading cableways, having under their spans the great storage and mixing yards. There are five cableways in this group. One of these is mounted on a pair of towers by itself, while the other 4 are mounted in pairs on two sets of towers.

After being mixed into concrete the materials will be conveyed in electric trolley cars to a track alongside the lock site under the second group of cableways. These electric cars are automatic in their operation, in that they require no motorman. There is a starter and stopper at each end of the track to control the motion of these cars whose speed will be 300 feet per minute. This second group of cableways, also having an 800-foot span, are mounted on traveling towers whose tracks are on either side of the locks and extend the whole length of the flight.

The cableways will pick up the mixed concrete and other materials for the locks at any point along the site and convey it at once to where it is to be put in place. In this group there are eight complete cableways mounted in pairs on four sets of towers, each pair of cableways with its traveling towers forming a complete traveling crane.

Not only are the hoisting line and carriage under the entire control of a single operator, but the towers are arranged to be traversed along their track by electric power. A system of remote control is provided which will enable the operator to take his station on a form on the concrete work, or at any point where work is actually being done and to operate the cableway in all of its functions from that point. He will also be able to have himself and his control apparatus picked up by the cableway and transported to another point of operation. The speed of operation of these cableways will be the greatest ever used for similar work. It is designed to traverse the carriages on the cables at a speed of 2000 feet per minute at full load. This plant is not completed as yet and when it is done, there will be many other novel features in its construction.

The Lock Cranes

At Pedro Miguel there will be one lock and at Mira Flores there will be two. For handling the materials at these locks, a different form of conveying apparatus will be used. At these locks the material must be brought by train because they are too far from the ocean for water transportation. It is expected that after the completion of the Pedro Miguel lock, the conveying plant will be transferred to Miraflores.

In order to handle the concrete, which, at Miraflores will consist of 1,150,000 cubic yards in the locks and 65,000 cubic yards in the dam at this point, there will be two types of traveling cranes em-

ployed. There will be four cranes of each type. What is known as the berm cranes are double cantilevers supported on a central tower running on tracks parallel to the lock walls. One end of the cantilever will extend over the material yards, while the other arm extends out over the locks. These cranes are outside of the lock walls, but inside of the lock chambers there is the second type of crane. These inside cranes travel on trucks running on tracks laid in the bottom of the locks and they have long cantilever arms extending over both lock walls. There will be two of these cranes in each of the lock chambers, each chamber being 1000 feet long.

Material will be handled from the storage piles beside the locks by grab buckets picked up by the first set of double cantilever cranes and delivered to the concrete mixers, which, by the way, are located on platforms on the crane itself. After mixing, the concrete will be carried by the other arm of the crane, swung out over the outer wall of the lock or delivered to the crane down in the lock between the walls.

Both types of crane can travel the entire length of the locks and approach walls and the storage pile will also extend over this distance, which amounts to about 3500 feet. The concrete mixing is done by machinery as on all work of any size. The capacity of the four units is estimated at about 2500 cubic yards per day.

There are many other uses of machinery on the canal which it is impossible to mention in such an article as this, in fact nothing at all has been said of the humble rock drill which is pounding and pounding away at the eternal rocks preparing them for blast and eventual loading on the cars. Indeed the work of building the Panama canal may be said to be a triumph of organization and sanitation together with the almost unlimited use of mechanical devices.

In the preparation of this article we are indebted to F. F. Coleman, of the Lidgerwood Company, for much material, and assistance in the getting together of facts and interesting data.

That Japan is taking a progressive view in the world's industrial development is evidenced by the new patent law which that country recently put into effect. In that law a strong guarantee has been given to the rights of patentees; the enjoyment of private rights has been brought into harmonious accord with the public interests; the rate of fees has been reduced, and the procedures for application for patents have been much simplified. The legal period for filing applications for patents has been extended to suit foreign applicants, and the provision relating to the cancelation of patents has also been revised to make the law adaptable to recent progressive development.

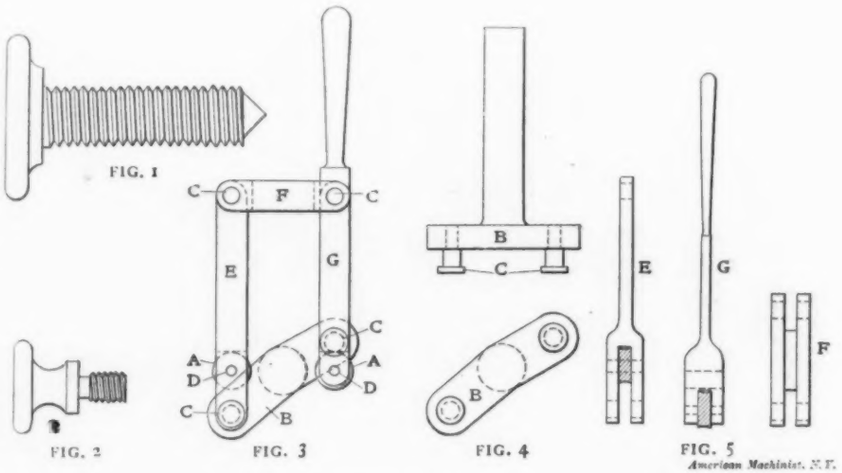
An Efficient Turret Nurling Tool

By John Bailey

On page 543 there is a description of a new turret nurl tool holder which recalled to my mind a turret nurling tool which I made about a year ago and which is still being used in our shop in a very efficient manner.

Things were very slow in the shop and to keep the men busy we looked over a lot of small work which we had been having done outside but which we thought might now be done more advantageously at home.

A couple of brass nurled finger screws, shown in Figs. 1 and 2, were among these, and we put them on a small turret lathe and made the necessary tools. I was struck with the saving that could be made by using a turret- instead of a tool-post-nurling tool; besides we needed the tool post for another tool and would have to keep changing, and if we could get a tool acting on both sides of the work simultaneously, we would be able to feed the tool in much faster as there would then be no bending action on the work to cause trouble.



A TURRET NURLING TOOL

The tool made is shown in Fig. 3, and several of its parts in Figs. 4 and 5. *B*, in Fig. 3 (and shown in detail in Fig. 4), is a T-shaped forging with the head of the T offset slightly, as shown. The stem is turned to fit the turret-tool arm, where it is held by set screws. Two pins *C* are screwed into the head of the T, as shown. On these pins are fitted the levers *E* and *G*, shown in detail in Fig. 5. These levers have the pins *D* for the two nurling wheels *A* which are standard stock nurls with concave faces. In the lever *E* the fulcrum is at the end, with the nurl above it, while in the lever *G*, which is longer and fitted with a handle, the nurl is at the end and the fulcrum in the middle.

The two lever arms are connected by a link *F*. This is made of two flat pieces, riveted together with a spreader between them. The offset in the T *B* was made to allow the lever arms to be of the proper length, to move the nurls the same distance.

In operation the turret is turned to position, and with the handle of the nurling tool to the rear, the carriage is brought forward until the nurls are opposite the part to be finished. A short, snappy pull on the handle does the trick, and it does not have to be much of a pull at that. The description of this operation reads as though it might be more or less intricate, but the nurling proved to be by far the shortest operation on the pieces.

Before trying the tool we were afraid that the nurling might overlap and cause a poor job, but in over 1000 pieces I failed to hear of one piece that has developed this fault.

We intend to try this tool on cylinder nurling. In order to do this, we will have to have the lever-supporting pins come out much farther in order to let the work pass into it. We would probably do this with some form of box tool, something on the line of that shown on page 543. A tool of this kind would be apt to cause uneven nurling as the hand pressure might not be constant, but as the tool we have has been such a surprising success we intend to make a trial on this kind of work.

The tool described has nurled the screws, shown in Figs. 1 and 2, which have head diameters of 1 and 1¼ inches, respectively, and the tool will take diameters of from ¾ to 2 inches. Of course, as the diameter of the piece to be nurled increases, the leverage becomes less and the cutting speed greater. This tool has been used on brass only, but we presume would work equally as well on other metals, but might require a longer lever arm for the handle to satisfactorily do the work.

Milling, Bending and Testing Fixtures

How Accurate Machine Parts Are Finished by Special Milling Appliances and Other Tools and Tested with Indicator and Micrometer Fixtures

EDITORIAL CORRESPONDENCE

The halftones, Figs. 1 and 2, and the line engravings, Figs. 3, 4 and 5, illustrate some special fixtures built by the Lanston Monotype Machine Company, Philadelphia, Penn., for milling spacing bars for the matrix cases used in their type-casting machines. Several of these spacing bars are shown on the table of the miller in Fig. 2, and detail dimensions are given in Fig. 3. A matrix case is also shown in the former illustration, and, as will be seen, there are 15 spacing bars located in the case, each bar having 15 pockets milled in its face so that the entire series when assembled in the case provide for holding 225 matrices which are used for casting as many different type characters. Each matrix is cut from a bar 0.2 inch square, the material being a copper alloy. The pockets in the steel spacing bars which receive the matrices must be accurate as to width and depth, and correctly spaced. The detail in Fig. 3 which gives the limit dimensions shows that the error allowed in the over-all measurement between the two outer ribs of the spacing bar is only 0.001 inch, and this means that all the intermediate pockets must be held very closely to size and be spaced correctly to avoid an accumulated error greater than that mentioned.

First Operation on Spacing Bars

The first operation, which consists in milling the entire series of pockets or notches in the bar of steel and cutting off to length, is accomplished with the gang of cutters illustrated in Fig. 1. In the second operation, Fig. 2, the work which now appears like a straight tooth rack, is passed lengthwise under a second gang of cutters which mill away the edges of the teeth to half their original hight, giving the work an L-shaped appearance when viewed from the end; that is, the second operation removes the metal at *A*, Fig. 3. The bar of steel from which these spacing bars are made is gripped as in Fig. 1, in a special fixture whose construction will be understood from Fig. 4. The two clamps *B* and *C* are mounted on this fixture at right angles to each other and hold the rectangular bar of stock against a seat in the block *D*. This block and both clamp plates are gashed, as shown, to admit the gang of cutters.

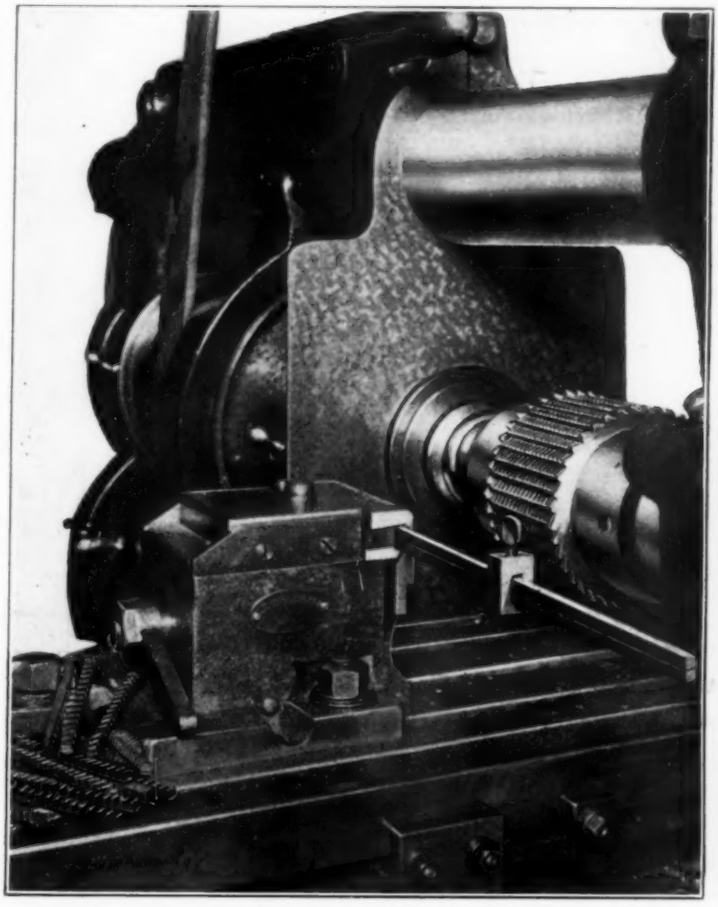


FIG. 1

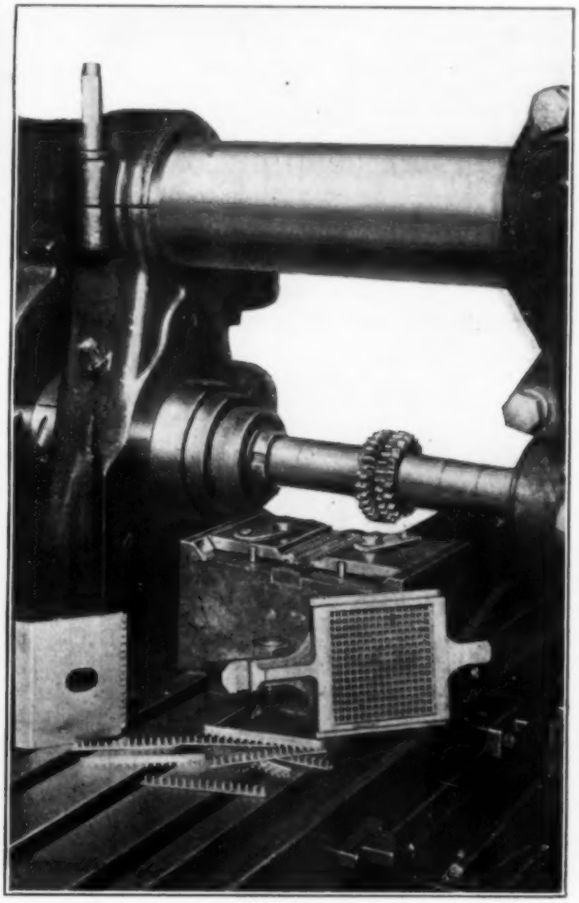


FIG. 2

MILLING MONOTYPE MATRIX-CASE SPACING BARS

The front clamp *C* is pivoted at the bottom so that it may be swung out of the way or brought into operative position quickly, and is provided with a latch *E* by means of which it is connected with operating bolt *F*. Top clamp *B* has a bevel surface underside near the rear end which rests on a corresponding slope on the fixture so that when tightened it tends to draw the clamp toward the rear.

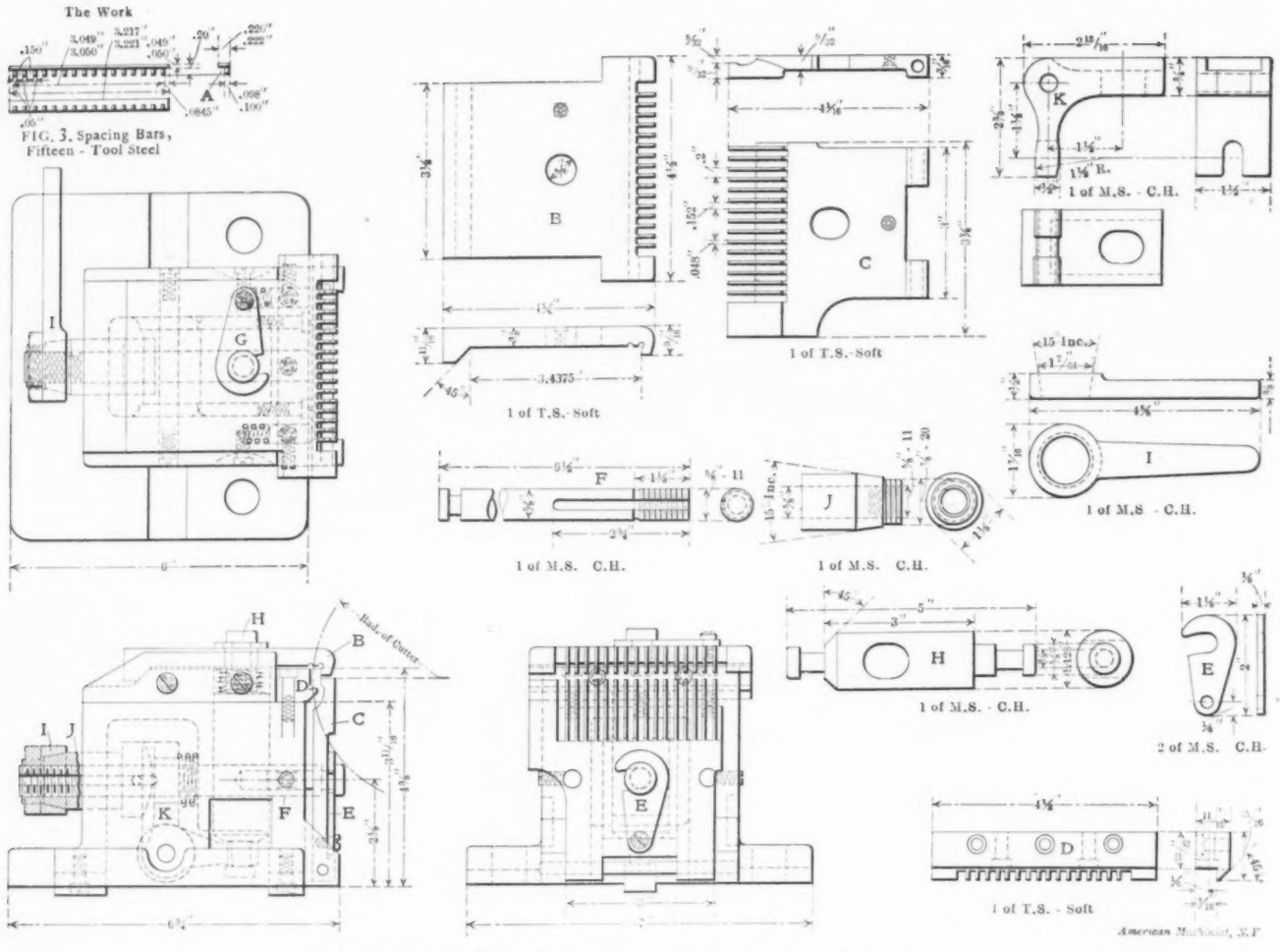


FIG. 3. Spacing Bars, Fifteen - Tool Steel

FIG. 4. FIRST-OPERATION MILLING FIXTURE FOR MATRIX SPACING BARS

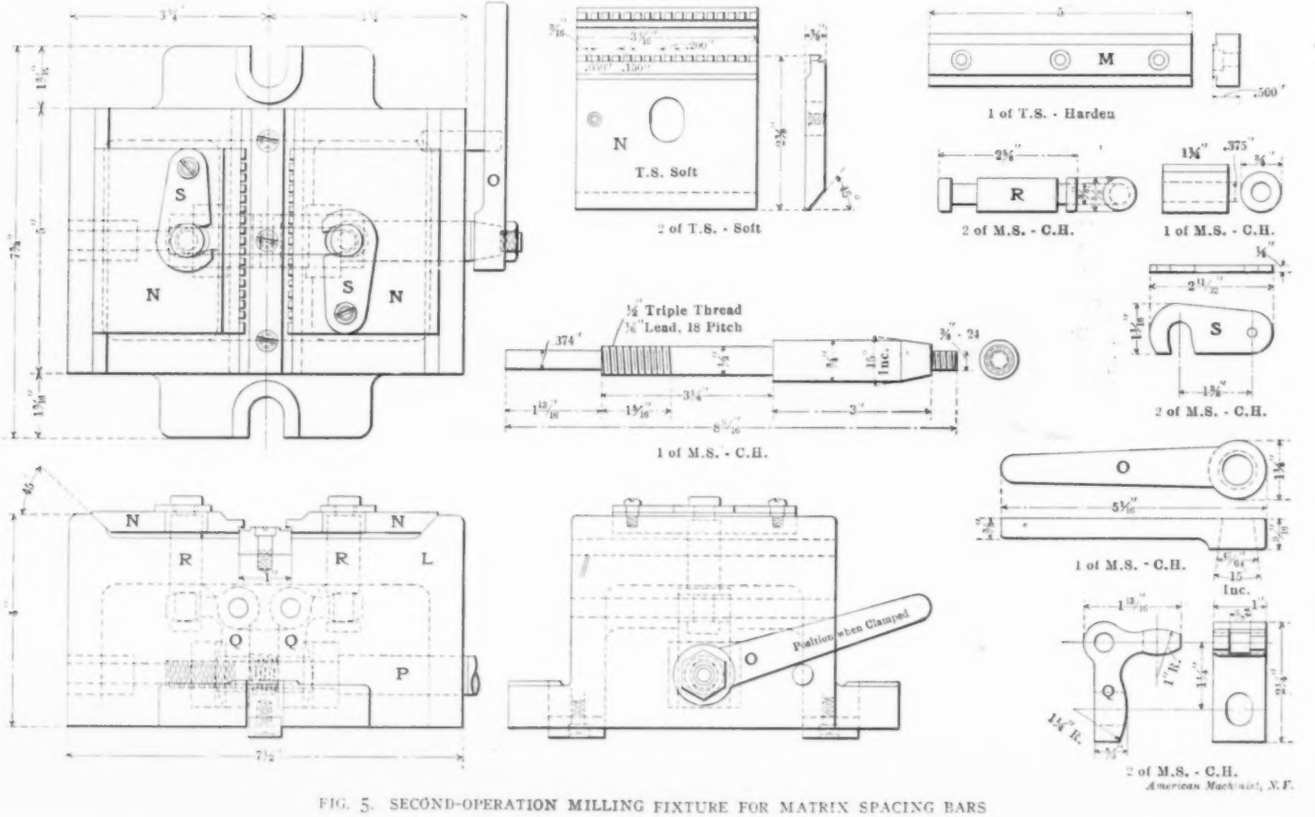

T.S. Soft
2 of T.S. - Soft
1 of T.S. - Harden
2 of M.S. - C.H.
1 of M.S. - C.H.
½" Triple Thread
⅛" Lead, 18 Pitch
1 of M.S. - C.H.
2 of M.S. - C.H.
1 of M.S. - C.H.
Position when Clamped
2 of M.S. - C.H.
American Machinist, N.Y.

FIG. 5. SECOND-OPERATION MILLING FIXTURE FOR MATRIX SPACING BARS

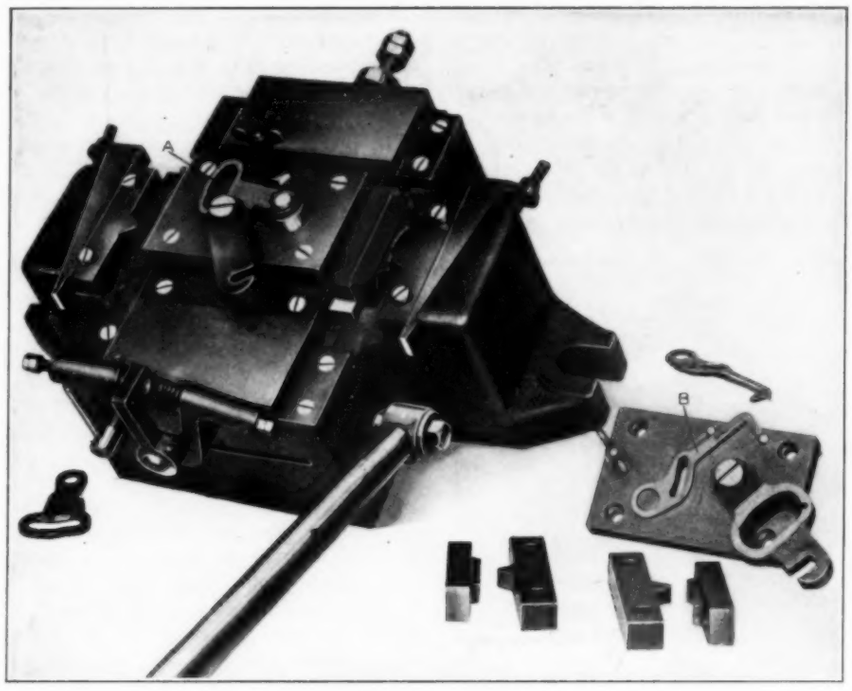


FIG. 6. FIXTURE FOR MILLING CAM SLOTS

This clamp also has a swinging latch *G* which secures it to the vertical operating stud *H*, and which, when swung back, allows the clamp plate to be easily removed. Both clamps are operated by a single movement of lever *I* which, when turned, operates a nut *J* on bolt *F*, forcing bell crank *K* forward, thus drawing down stud *H* and clamp *B* and also drawing back bolt *F* and clamp *C*. Movement of lever *I* in the opposite direction simultaneously releases both clamping plates. A spring acting upon the bell crank *K* tends to throw this back when the nut *J* is released, and a similar spring lifts the upper clamp *B*. Two spring plugs press against the inner face of clamp *C* and swing this away from the work when the clamp bolt is released.

When the cutters have been run into the work to the proper depth, the table then coming against a positive stop and the piece being cut off to correct length by the two larger cutters at the ends of the gang, the clamps are released, the front one dropped out of the way and the upper one removed. The bar of stock is then reset, the clamps replaced and the next piece milled. Both clamps, as well as the seat for the work, are readily cleaned, and the work is thus always held true and firmly in place during the milling operation.

Second-operation Fixture

The second-operation fixture, Figs. 2 and 5, in which these matrix-spacing bars are milled lengthwise, reducing the hight of the teeth and leaving a ledge at the rear, as seen in Figs. 2 and 3, consists of a base *L*, Fig. 5, in the face of which is inserted a steel block *M* for receiving two of the spacing bars at the same time; the work being held by clamps *N N*. These clamps are simultaneously operated by handle *O* on threaded spindle *P*, which acts upon rocker arms *Q* and causes the latter to actuate rods *R R* and draw clamps *N N* down upon the work. The clamps, as in the case of the first-opera-

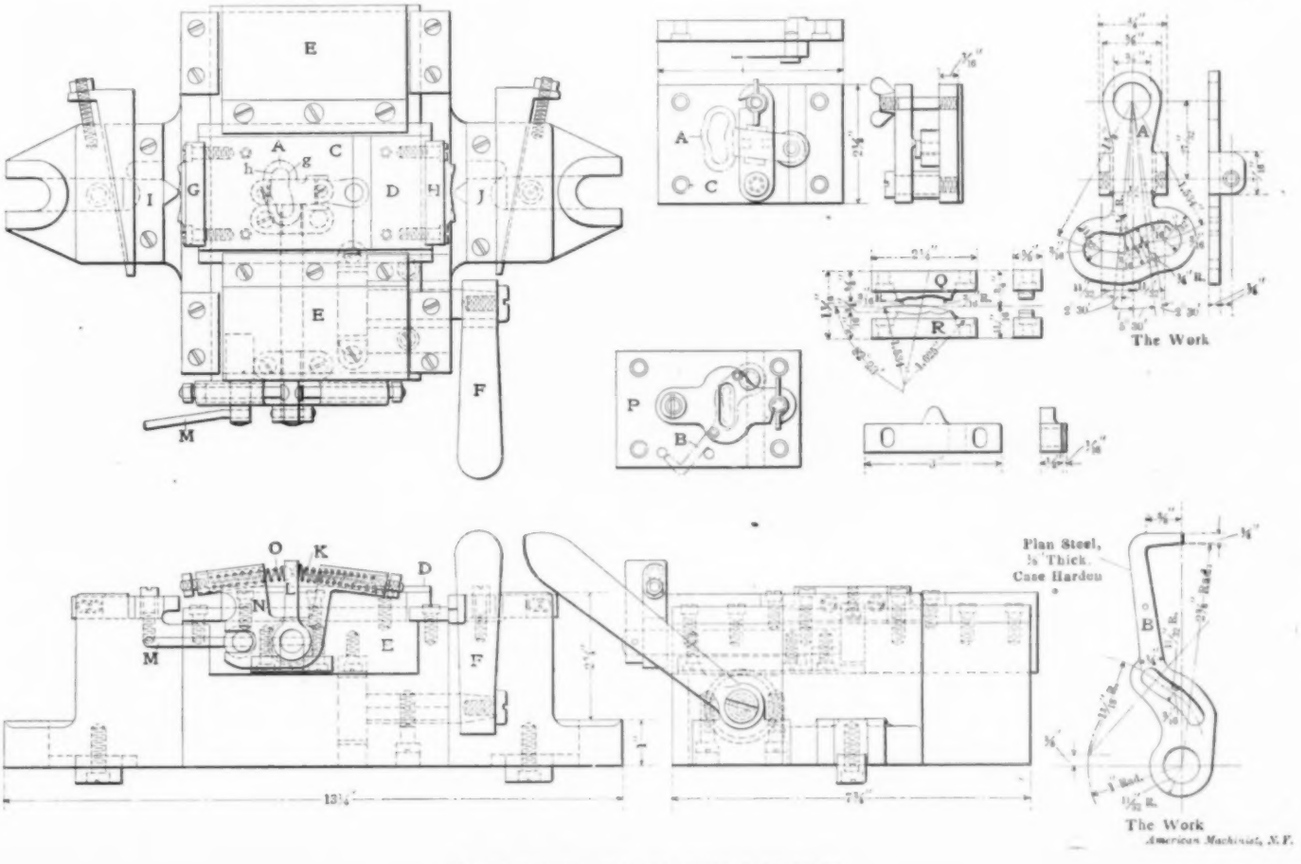


FIG. 7. FIXTURE FOR MILLINC CAM SLOTS

tion fixture, are provided with swinging latches *S S*, which connect them with studs *R R*, and which when swung back, allow the clamps to be lifted off so that the work may be readily removed and the clamps and seat for the work properly cleaned of oil and chips.

The clamps also serve as receivers for the work, as the notches cut in their ends admit the teeth of the spacing bars, so that while a pair of these spacing bars are being milled another pair are inserted in the ends of an extra pair of clamps which are dropped into the fixture when the first pair are removed with the completed work. In this way little time is lost in removing and inserting work.

The details in the drawing, Fig. 5, give the principal dimensions of the various members of this fixture. It will be noticed that the rear ends of the clamp plates *N N* are beveled and rest upon corresponding bevels formed in the upper face of the fixture, so that when tightened the clamps are also pressed forward to seat the work firmly against the locating shoulders on seat *M*.

Fixture for Milling Cam Slots

Figs. 6 and 7 illustrate a fixture with which some profiling operations are accomplished. There are a number of parts like *A* and *B* having cam slots which have to be finished to correct outline, and this fixture handles such work advantageously. Piece *A* is shown in place on the fixture and the method of clamping needs no explanation. The receiver *C*, by which it is carried, is attached to a cross slide *D*, Fig. 7 mounted in main slide *E* which is operated in the fixture by a handle *F*, attached to a shaft carrying on its inner end a pinion engaging with a rack fastened underneath slide *E*. When slide *E* is operated, the movements of cross slide *D* are controlled by cam plates *G* and *H* adapted to contract respectively with fixed blocks *I* and *J*. Cam plate *G* is shaped to suit one side of the slot in the work and *H* is of proper form to suit the other side of the slot. As illustrated, the fixture is set for milling the side *g* of the slot, the cam plate *G* being held in contact with guide block *I* by pressure of spring

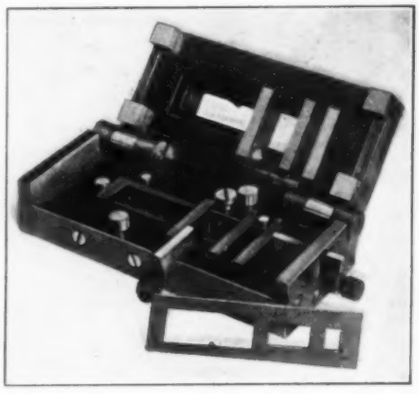


FIG. 8. A FILING JIG

K against arm *L*, which acts through a pinion and rack upon the cross slide *D* and forces that slide to the left against block *I*.

An end mill in the vertical spindle milling attachment is dropped into the slot and when the handle *F* is operated the side *g* of the cam slot in the work is milled to correct contour. Cam handle *M* is then swung down rocking spring bracket *N* toward the right, releasing the pressure of spring *K* against the lever *L* and causing spring *O* to act upon that lever. This spring then forces the cross slide to the right and holds cam plate *H* in contact with block *J* while the main slide is again operated by lever *F* and side *h* of the cam slot in the work milled to correct outline. The end mill is, of course, enough smaller than the slot so that it can cut on only one side of the work at a time.

The method of adjusting the guide blocks *I* and *J* will be understood from the engravings and the details of the fixture need little description. A stop is provided as shown at the rear end to limit the forward and backward travel of the main slide and work. When it is necessary to change the fixture for another job, as for handling piece *B*, the block *C* is removed bodily from the cross slide *D* and block *P* substituted. Cam plates *G* and *H* are also removed and another pair, *Q* and *R*, attached in their place.

A Filing Jig

A built-up filing jig is illustrated in Fig. 8. This is used in finishing the inner edges of the mold blade shown in front of the jig. The blade to be finished is nested between a series of pins and further secured by two jaws operated by the nurled-head screws at the front and end of the jig. The inner ends of the jaws slope backward from the top thus tending to seat the work properly. Hardened-steel blocks are inserted in the body and lid at points corresponding to those edges of the blade which have to be filed, and when the blade is shut up in the jig it is a simple matter to finish it correctly. If in the course of time, one of the hardened blocks which limits the action of the file becomes worn it may be readily replaced; so this sectional jig is not only easier to construct than a solid one would be but is also kept in order at less expense.

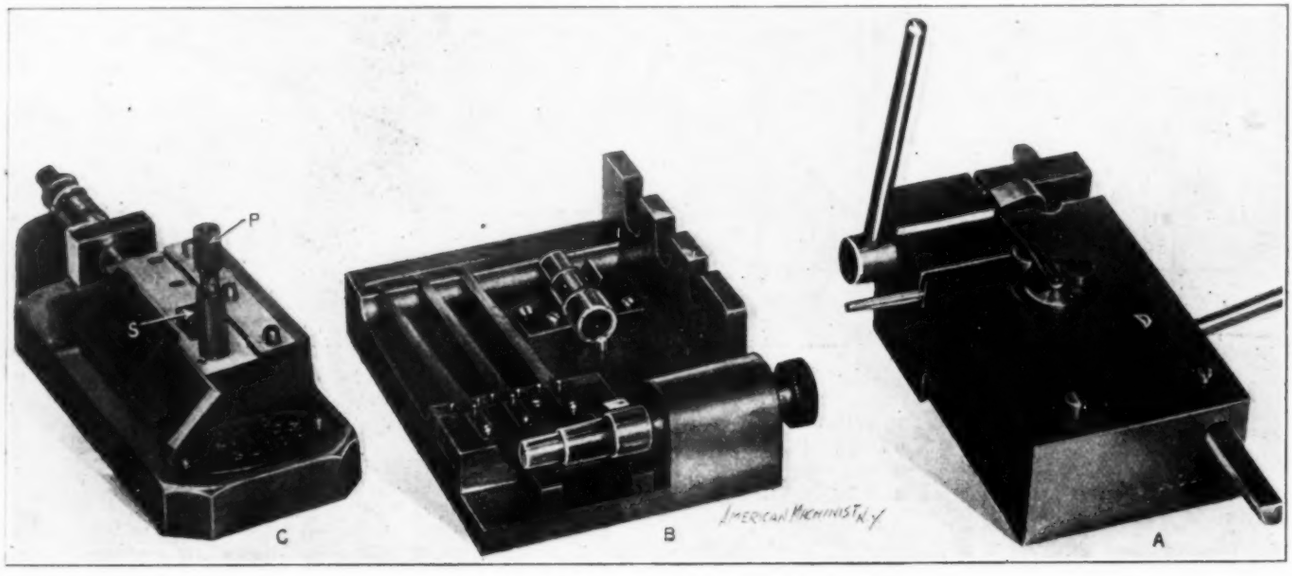


FIG. 9. TESTING AND BENDING FIXTURES

A Bending Fixture

In Fig. 9 two testing fixtures and a

bending device are shown. The latter, which is illustrated at *A* in this halftone and shown in detail in Fig. 10, is used for bending a piece of steel wire into the form of a spring catch as shown at *D*, Fig. 10. The bent piece completed is also shown in the fixture *A* in the halftone. The wire is 0.063 inch (No. 52 Stubs steel-wire gage) and is cut to lengths of about 2 11/32 inch. In bending, a piece of wire is slipped into the hole in the end of rod *E*, and the end which projects about 5/16 inch is gripped between jaws *F*. The rod *E* is flattened on one side so it will rest at the right hight on the face of the fixture, and after the end of the wire has been gripped in the jaws, the rod is swung to the right until it strikes stop pin *G*. This forms the slight bend shown at *a* in the detail sketch *D*. The rod *E* is now drawn back on the wire far enough to allow slotted plug *H* to be elevated in its seat sufficiently by its projecting handle to engage the sloping portion of the wire and hold it while the rod *E* is swung back against stop pin *I*, this movement forming the bend at *b* which sets the outer end of the wire parallel with the inner end which is gripped between the jaws *F F*. The effect of the two bending operations, however, has been to offset the outer end of the wire 3/64 inch from the gripped end as indicated in the detail *D*. Rod *E* is next drawn back on the wire to allow plug *J* to be lifted above the face of the fixture by handle *K* so that the wire will be engaged between roller *L* and central pin *M*. The rod is then withdrawn entirely from the wire and handle *K* utilized to rotate plug *J* a half turn, this movement bending the outer end of the wire around central pin *M* and forming the loop *c* shown in detail *D*, this completing the bending operation.

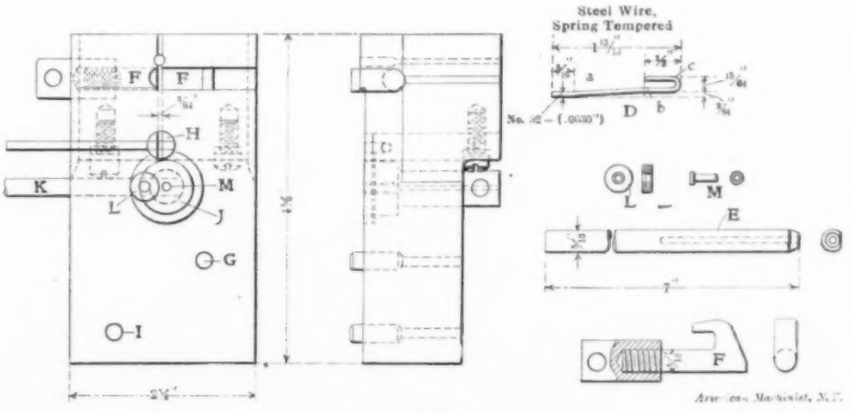


FIG. 10. BENDING FIXTURE

Two Testing Fixtures

The fixture *B*, Fig. 9, is for testing a special shoulder stud which is shown in place in the fixture. A master stud by which the fixture itself is tested is shown held in the spring clip near the upper right-hand corner of the device. The three diameters of the stud are gaged by the limit gage secured to the right-hand side, each of the three openings therein having two widths, as represented in the detail sketch Fig. 11 so as to form a tandem limit gage. The maximum and minimum sizes in each gage opening are given in the sketch. The lengths of the stud and the different portions of the body are tested by the three indicator pointers while the stud head is held in contact with the nurled setting plug to the right. The outer ends of the indicators swing over graduations reading to thousandths on the face of the fixture and any error in the over all length of the stud or in the distances between shoulders is detected at once.

The fixture at *C*, Fig. 9, is one of a number fitted with micrometer heads for testing various pieces. The gage illustrated is for testing what is called the forward stop on the mold blade. One of the blades is shown resting against the side of the fixture. This blade, which is hardened, ground and lapped, when in use slides back and forth in the mold to give the required width of type body, the movement being limited by the rectangular opening at the center of the blade. In testing, the nurled-head square plug *P* which has a round pilot fitting a hole in the fixture, is slipped through the hole at the rear end of the blade, thus locating the blade on the device ready for testing. The jaw *S* which forms a part of the slide operated by the micrometer spindle is then traversed by the micrometer until it contacts with the end wall of the central oblong opening in the mold blade, the micrometer reading showing at a glance if the surface tested is the exact distance required from the test plug.

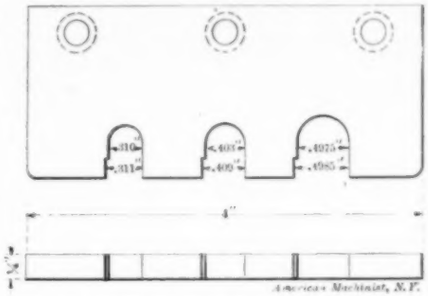


FIG. 11. GAGE PLATE FOR TESTING FIXTURE

An Exhibition of Blue Chip Steel

Editorial Correspondence

For the two weeks from the 8th to the 19th of June inclusive Wheelock, Lovejoy & Co.'s New York branch gave an exhibition of the cutting qualities of the Blue Chip steel manufactured by the Firth-Sterling Steel Company.

The exhibition was given in Gould & Eberhardt's, Newark, N. J., and this gave them an opportunity to exhibit their 16-inch shaper. The Powell Tool Company, Worcester, Mass., had their accelerating cut planer there; E. C. Bliss Manufacturing Company, Providence, R. I., had a die milling machine on exhibition, as well as some of the high-speed steel mills and cutters which they make; and the O. K. Tool Holder Company, of Shelton, Conn., had their tool holders in use on the different machines as well as an exhibition of the different sizes of these that they make.

Some very interesting work was done on the different machines, and Fig. 1 shows a big cut which is being taken on the Powell accelerating cut planer. The piece that is shown on the platen as it is being cut is a cast-iron block nine inches wide and five feet long. The cut shown is being taken by a Blue Chip high-speed steel tool, 1 by 2 inches, that was hardened in water. The cut was 5/8 inch deep with a feed of 1/8 inch, and this made the width of the chip 7/8 inch. The tool was started at the rate of 40 feet per minute and when it had cut into the stock about 2 inches the speed accelerated to 120 feet per minute. Just before leaving the cut it again decreased to the 40 feet so the platen would reverse easily. This tool had been used off and on for six days without regrinding, when it was making the cut shown in the picture.

A roughing cut was taken in the same block with the O. K. tool holder shown on the end of the platen. This cut was 1/4 inch deep, 3/8 inch feed and the accelerated speed was 140 feet per minute. It planed across the surface of the block, which was 9 inches wide and 5 feet long, in four minutes. Another cut 1/2 inch deep with 1/8 inch feed was made across the block with this tool holder in six minutes.

Test in Shaper

Another series of tests was made in the 16-inch Gould & Eberhardt shaper that is shown in Fig. 2. This machine can be run at from 7 to 125 strokes per minute. The block which is being machined is cast-iron and 12 inches long. The stroke was made 14 inches and 24 strokes per minute were taken. The cut shown is 5/8

FIG. 1. POWELL ACCELERATING CUT PLANER USING BLUE CHIP TOOLS

FIG. 4. BLOCK ¾ INCH THICK AFTER MILLING

inch deep with a feed of 1/20 of an inch. This heavy cut was taken with an O. K. tool holder. This seems like a pretty heavy cut for a small shaper, but with the Blue Chip steel it was taken successfully.

Demonstration on Die-milling Machine

Another machine that was run during the two weeks of this exhibition is shown in Fig. 3. This is a machine for milling dies that is made by the E. C. Bliss Manufacturing Company, and it runs at 700 revolutions per minute. It is shown with a die in it that was being cut with the Blue Chip cutter shown in the center of the die. This die was made for punching out the word "Maxwell" from brass plates; the finished product being shown on the machine, under the pulley. Some of the different styles of cutters which were made for use in this machine are shown, in a circle, on the board, at the base of the machine.

One die block that was cut during the exhibition is shown in Fig. 4, and with it is shown the cutter that was used for the work. Only the part of the block that was cut is shown, as it was not necessary to show the entire block. The letter is about 3½ inches high and it was cut with this Blue Chip cutter in 45 minutes.

Wheelock, Lovejoy & Co. also had their barium-chloride furnaces for hardening steel on exhibition and all tools used were hardened on the premises in order to instruct others in its use.

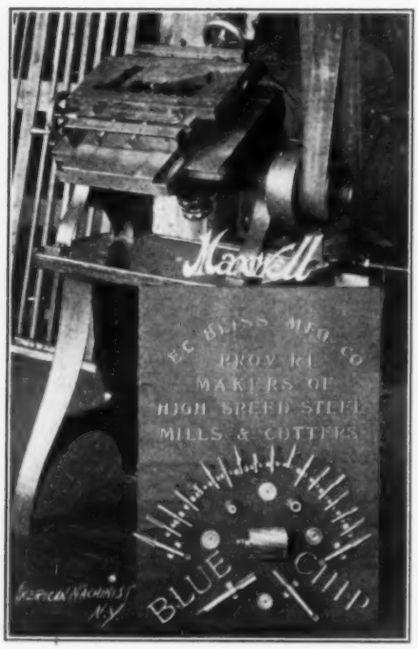


FIG. 3. BLISS DIE MILLING MACHINE

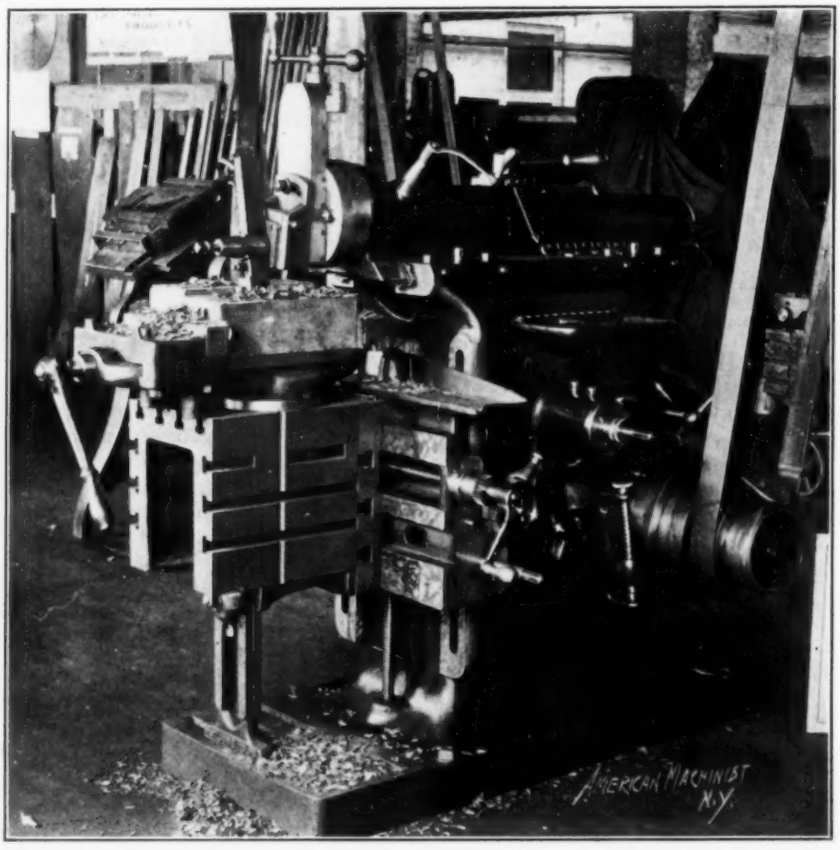


FIG. 2. GOULD AND EBERHARDT'S 16-INCH SHAPER USING BLUE CHIP TOOLS

The Vail Family and the Speedwell Works

Sketch of a Machine-shop, Recently Burned, Which Pioneered the Steamship, Locomotive, Cast-iron Plow and Telegraph Industries

BY EDWARD P. BUFFET

About the beginning of December last, the newspapers made mention of a destructive fire at the old Speedwell Iron Works, near Morristown, N. J. They had been idle for nearly half a century, yet enough of them remained to furnish food for the flames. Their existence had been almost totally forgotten in machinery manufacturing circles, but their end recalls to mind an extraordinary record of achievement in the history of American engineering. Their obituary is like that of some great man from a past generation, of whose late survival among us we are—as often happens—made aware only by the announcement that he has passed away.

The Speedwell Iron Works deserve recognition on at least five independent grounds: First, because of their historic beginning, they having been founded, in Revolutionary times, at a town which more than once was occupied as winter quarters by the Continental army. Second, because thence came the machinery for the "Savannah," the first steamship to cross the Atlantic ocean. Third, because the first (?) cast-iron plow made in America was there produced. Fourth, because there were forged tires, axles and cranks for the earliest American locomotive. Fifth, because that plant was the home of the first commercial electrical industry in the world—the magnetic telegraph.

Beginning of the Works

In the winter of 1778-1779 the *New Jersey Gazette* was advertising that a store had been opened at Morristown, by Arnold, Kenney & Co., to sell dry goods, groceries, testaments, spelling books and other articles enumerated. In June, 1779, the firm announced dissolution of its partnership.

These men, Jacob Arnold, captain of "Arnold's Light Horse," and John Kenney, or Kinney, were the founders of the Speedwell works, the nucleus of which they established, somewhere about the period of the Revolution, in the form of a slitting mill. A local historian tells us that it was the *second* slitting mill in Morris county.

In Re Slitting Mills

Thereby hangs a tale. The *first* slitting mill in the county must have been that of Samuel Ogden, at Old Boonton. Slitting mills were plants for splitting up iron into nail rods, horseshoe iron, etc., with grooved rolls, after first rolling it into plates. The rods were then sold for working up into wrought nails by blacksmiths, or as a household industry. Under the British Act of 1750, the erection of plants for making semi-finished iron products, such as the slitting mills, had been prohibited to the colonists. It is related that Samuel Ogden built a plant of that sort while this law was in effect and that the upper story, entered from the river bank, was arranged as a grist mill, to assume upon short notice the functions of innocent industry whenever the governor chanced along for an inspection tour. What with "jagging" the governor previous to the inspection and giving him an interest in the business, the mill was allowed to run unmolested.

The Golden Age of Failure

After the revolt of the colonies the restraining act of Parliament became a dead letter and those who wished to build slitting mills availed themselves of the opportunity to do so. It is not unlikely that the water power on the Rockaway river, north of Morristown, where Arnold and Kinney put up their mill had been used for forging purposes long previous to that. Their new undertaking died abornin', owing it is said, to irremediable defects in the plant. Another account of the Speedwell works tells us that a building put up for a cotton factory became used for button making instead because of some inherent fault. These anecdotes may be varying versions of the same story. But, at all events, the proprietors of the slitting mill were financially swamped.

The paths of early American industry are strewn with bleached bones of enterprises that fell in their tracks. This fact must be patent to everyone who studies the history of early iron working. In these days of trusts we are prone to look back enviously to the country's childhood as a golden age, even for small and lazy men. But local records tell another tale, informing us how hard the first forgemen and furnacemen toiled for a livelihood, and with what regularity they were doomed to failure. Some of them, to be sure, made money, then as now, made it and spent it lavishly, but the day of an assured competency for the mediocre iron man is a myth.

Judge Vail on the Work Bench

Captain Arnold's interest in the business was sold under legal proceedings, in 1796, to Dr. Timothy Johnes. Since the Captain was Sheriff he could not sell himself out, so the coroner did the job. In 1807, Johnes turned over his holdings to Stephen Vail, who, in partnership with William Campfield and Isaac Canfield, proceeded to improve the plant. As then developed it comprised a trip-hammer works, blacksmith shop, coal house, turning shop, etc. The principal new construction is believed to date from about 1812. Thus the Speedwell Iron Works had assumed their proper character of a machine, as well as a forge shop, competent to cope with the task of steam-engine building, which was elbowing to the front. In 1814 the plant became entirely the property of Judge Stephen Vail, under whose management it was destined to be a famous, if not a huge, establishment.

Equipping the "Savannah"

That historic voyage of the "Savannah" began May 26, 1819, from the Georgian city whence her name was borrowed. As she smoked past the Irish coast, she was chased for a day by the revenue cruiser "Kite" which took her to be a ship on fire. The "Savannah" was a vessel of 350 tons burden. The contribution to her equipment that went from Speedwell is variously referred to by "historians" as "engine," "boiler," "shaft" and "machinery." Let us assume that they are all true. The heavier forging seems to have been done at Speedwell. Some of the lighter machinery was constructed at Elizabethtown, N. J., the point of water shipment through which the product from Morristown was forwarded to New York.

The First Locomotives

Obscurity enwraps the part played by the Vails in furnishing tires, axles and cranks for the earliest—or among the earliest—locomotives built on this side of the Atlantic. Nelson, in his "History of the Jersey Coast," states that, in 1825, the first steam engine for passenger purposes was constructed at Hoboken. This may have been one of the locomotives that levied tribute from the Morristown forges. While the first practical run of a locomotive did not take place until four years later, and she was the "Stourbridge Lion," imported by Horatio Allen from England, it does not follow that no experimental railroad engines were earlier built in the United States.

First(?) Cast-iron Plow

There is a tradition that "the first cast-iron plow," in the United States at least, was made at the Speedwell Iron Works,

and further, that its inventor was Mahlon Johnson, of Littleton, Morris county, N. J., although a patent on a cast-iron plow was afterward obtained by Freeborn, of New York, whose name it bore. Speaking of agricultural machinery, it is error to suppose that our great-grandfathers knew of naught beyond the hand for sowing and the sickle for reaping. Improved implements, such as seed drills and novel forms of plows, were numerously invented before the year 1800.

The Marquis of Crevecœur, who visited the Sterling Iron Works, Orange county, N. Y., about 1790, says that Mr. Townsend, the proprietor, told him:

"What a pity you did not come here eight or ten days earlier! I would have shown you, first, three new kinds of plows, the principal parts of which I have cast, and which are no heavier than the old-fashioned. Each is provided with a kind of graduated steel-yard by which one can tell with precision the tractive power and soil resistance. Second, there was a portable mill for separating the grain from the chaff. There was yet another invention by means of which all the ears of grain of a field may easily be gathered without need of cutting the stalks at the root to make it into sheaves as formerly. All this has started for Mt. Vernon, since General Washington . . . directs the cultivation of his immense estate with a discernment and attention worthy of eulogies."

So it would appear that Washington used both cast-iron plows and traction dynamometers. Not everything that is new to the inventor is new to the world.

Robert Ransom, of Ipswich, England, is credited with the first patent for making cast-iron plowshares, in 1785. In 1803 he improved them by a chilling or case-hardening process. The first cast-iron plow made in America is attributed to Charles Newbold, of New Jersey, to whom letters patent were granted in 1797. He spent over $30,000 in exploiting it, but gave up in despair because the farmerly intellect maintained that the implement poisoned the land, injured fertility and promoted the growth of rocks. Thomas Jefferson was a plow inventor, not only conducting practical experiments on his estates about 1793, but communicating to the French Academy his attempted solution of the true mathematical surface of the mold board.

In passing it may be remarked that as late as the 19th century plows were drawn in Ireland by hitching them to the tails of the oxen or horses.

Nail Making—A Stolen Secret

A story has often been told, how long ago a valuable process was exclusively employed at a certain European factory by maintaining utmost secrecy. One bitter cold night a forlorn tramp came to the works and implored that he might lie down and warm himself by the furnace fire. It seemed that no harm could come from granting his request, so for once the rule against admitting strangers was relaxed. That tramp was a rival manufacturer in disguise, and, by abusing hospitality, he stole the secret.

The old-time process of making nails by hand has been already mentioned in relation to the slitting mill at Speedwell. Manufacture of cut nails by machinery came in during the closing years of the eighteenth century, at which time nail-making machines were a favorite exercise for inventors. One of the best known of the early nail factories was that of J. Pierson, at Ramapo, near the boundary line between New York and New Jersey. It was against his rule to admit visitors. Stephen Vail was then a young man with a mechanical and inquisitive temperament. He had heard of the marvels in Pierson's factory, and the exclusion of spectators only enhanced his curiosity. In the guise of an ignorant country bumpkin, he gained access and strolled about the shop with an air of idiotic bewilderment. Just then Mr. Pierson happened to enter the room and, noticing that the amazement of this young jaybird was focussed upon a particular machine, he hastened to speed the parting guest.

It was to Mr. Pierson an inscrutable mystery how, some time later, a nail-cutting machine came to be set up at Dover, a few miles from Morristown, and he never found out until, many years afterward, Judge Stephen Vail told him about it as a friendly joke. He was then able to look at it in that light.

By the time Stephen Vail came to sit on the bench as a magistrate, he ought to have learned some things in point of ethics which had not been clear to him as a boy. But from the relish with which he seems to have repeated this story in old age, it may be feared that he never came to realize how small a difference lies between stealing the design of a machine and stealing the machine itself.

The Magnetic Telegraph

Judge Stephen Vail's sons, Alfred and George, both took after him in mechanical aptitude and started in to work at the Speedwell plant. George settled down and remained as a partner, but Alfred had other ideas and, at the late age of 25, entered New York University, intending to study for the ministry. He was graduated in 1836, but his health broke down and prevented his further education along that line. Occasionally he returned for a visit to the university, and one of these visits, September 2, 1837, revolutionized not only his career but the history of the world.

Prof. Joseph Henry, of Princeton, had already invented an electromagnetic telegraph, in essence; it remained to commercialize the principle. Different inventors were struggling with the practical difficulties involved, whether on the basis of Henry's researches or otherwise. A definite conception of a working telegraph shaped itself in the head of Samuel F. B. Morse, an artist, on October 19, 1832, while he was returning from France on board the packet "Sully." Several years elapsed before he could embody his plan, but after having been admitted to the faculty of New York University he constructed an experimental apparatus and tried it with the assistance of Prof. Leonard D. Gale.

It was an exhibition of that instrument which Alfred Vail witnessed. Forthwith he became an enthusiast on this new application of natural powers and sought to cast in his own lot with its development. Morse lacked funds, while the Vails were people of substance. The inventor readily promised a quarter interest to Alfred, who enlisted the patronage of his father. After prudent inquiry the doors of Speedwell were thrown open for construction of an instrument suitable to place before a congressional committee and $2000 were provided as wherewithal. Morse was invited to Morristown on a tentative visit and was encouraged incidentally by an order to paint portraits of the Vail family.

Electrical Construction in the Thirties

In one of the buildings of the Speedwell works, construction of the apparatus was begun, with due precautions of privacy, by Alfred Vail in person. His confidential assistant was a young apprentice named William Baxter, later designer of the Baxter engine. The machine at which they worked was to be a recording telegraph, and necessarily complicated, for the sounding principle is of after adoption and the simplicity of the modern receiver has been attained by discarding the characteristics of Morse's invention. Insulated electrical wire was then unknown to trade and hence milliners' cotton-covered copper wire was used as a substitute, the New York market being drained of it for the purpose.

The mechanical skill that Alfred Vail used in carrying out Morse's idea was not all that he gave to it; he added features that were not mere improvements of mechanism, but fundamental principles, entitling him to credit as co-inventor.

The task was a tiresome one, and long before it was accomplished, Judge Vail's early complaisance had changed into skeptical disgruntlement at the dubious prospects for his investment and the jeers of his neighbors. Diplomatic relations between him and Alfred were almost suspended. When finally summoned to see the telegraph work, he wrote the trial message, "A patient waiter is no loser," saying that if Morse could read it at the other end of the line he would be convinced. When it actually was read his depressed spirits rebounded to the clouds.

On the sixth of January, 1838, Morse,

Alfred Vail and Professor Gale worked the instrument. A few days later an exhibition was given to 100 or more spectators from the surrounding country. The messages were transmitted through about three miles of wire. A ten-mile line was being prepared for the congressional committee.

There yet remained the hardest struggle of all, to secure an appropriation for erection of a real commercial telegraph. Not until the last hour of the session ending March 3, 1843, when Morse had despaired of the passage of the bill, and when his assets were reduced to the fraction of a dollar, did it come to a favorable vote in the Senate.

Still the project was brought to the brink of failure. When laying the wires underground in pipes between Washington and Baltimore, with a pipe-laying machine of Ezra Cornell, the insulation proved defective. The appropriation was nearly exhausted with no prospect for another. But the wires were finally strung on poles and, May 24, 1844, the famous first message, "What hath God wrought!" dictated by Miss Annie Ellsworth, went through the line. Alfred Vail was the operator at Baltimore who received this message.

Credit to Alfred Vail

Alfred Vail was partner with Morse in the labors, vicissitudes and profits of the telegraph; he had secured the pecuniary means and with his own hands performed the work of its construction; but, more than this, he was the inventor of elements which should have brought him a large part of the glory that has been harvested by Morse.

Vail's chief inventions were three: The dash-and-dot alphabet; the lever motion employed to actuate a pen, pencil or style; and a lever with grooved roller which embossed the paper. He was a modest man, yet he chafed somewhat at the lack of justice shown him, but various motives held him back from claiming his due. It is said that in the modern simplification of the telegraphic instrument, all features that Morse invented have dropped away, the permanent elements being those put into it by Joseph Henry and Alfred Vail.

Vail was the author of a little book on "The Electro-Magnetic Telegraph." He died, Jan. 18, 1859.

Speedwell Iron Works in 1853

They never became a great establishment in point of business, though for their day they were of creditable size as a country shop. Situated by the Rockaway river, on one of the most beautiful spots in a splendid region of mountainous country, they were a place where a man could work as a mechanic and still enjoy the quiet delights of an expansive Nature—a combination of advantages which is growing more and more remote from possibility for the average machinist or engineer.

A report on the condition of the works in 1853 shows that they were then occupied in making heavy and light forgings, press screws, car wheels and axles, machinery for saw, grist and paper mills, etc. In the foundry were employed six molders, eight men in the blacksmith shop and 10 in the machine shops, making with common laborers 45 men who filled a pay-roll of some $14,400 per annum. It took a year to consume 300 tons of coal, 200 tons of pig iron, etc., from which was turned out a product valued at $50,000. The works in their day catered largely to the Southern and South American trade in the way of sugar mills, coffee hullers, etc.

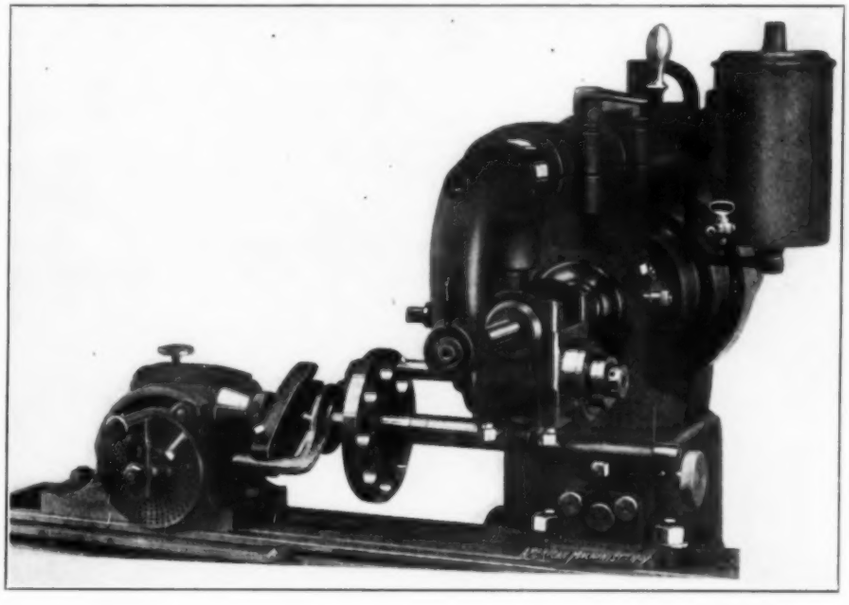
Judge Stephen Vail and his son, Hon. George Vail, were alive in 1853, and Isaac A. Canfield, a descendant of the Judge, was a member of the firm. Stephen Vail died in 1864, at the age of 84 years, and soon afterward the Speedwell Iron Works closed their doors. It has been thought that their idleness was due to a provision in the Judge's will hindering their sale or their operation by other than certain named persons.

The name "Speedwell" was borne also by one of the numerous old-time forges in the bog-iron region of south Jersey. This forge may have been controlled by the works at Morristown and used by them for the supply of raw material.

From a statement made before the Engineers' Society of Western Pennsylvania, the petroleum industry in the United States originated in the Great Kanawha Valley at the Salt or Buffalo Lick, near Charleston, W. Va., where David and Joseph Ruffner drilled a hole into the salt sand with a 2½-inch chisel bit of steel attached by a rope to a spring pole and were rewarded on January 15, 1808, by an ample flow of brine for their salt furnace.

Boring a Jig on the Miller

The halftone illustrates an interesting boring operation recently accomplished at the shops of the Fox Machine Company, Grand Rapids, Mich. A jig had to be bored having 8 holes spaced equi-distant and the halftone shows how the job was done on a No. 3½ Fox miller with the universal dividing head and vertical attachment for this machine. The plate to be bored was mounted on a mandrel supported by the universal dividing head and tailstock on the top of the milling machine. The vertical attachment which may be swung from vertical to horizontal or any intermediate position was adjusted to the horizontal position and in it was mounted a short boring bar; this arrangement enabled the regular table feed to be used and the plate to be indexed for the different holes thus making possible a quick operation and an accurate jig, as the error in spacing was found to average not over 0.0005.



BORING A JIG ON THE MILLER

The United States Forest Service is planning to introduce a number of the more important eastern hardwoods into California, and will this year experiment with chestnut, hickory, basswood, red oak and yellow poplar or tulip trees. Small patches of these trees will be planted near the forest rangers' cabins on the national forests, and if these do well larger plantations on a commercial scale will soon be established on wider areas. Among the hardwood trees in California there is not a single species that ranks in commercial importance with the leading eastern hardwoods and the plan to be tried promises well.

Practical Letters from Our Readers

A Round Table Discussing Details of Modern Machine-shop and Drawing-office Methods, Practice and Economy

WE PAY FOR USEFUL IDEAS

Progressive Drawing, Piercing and Blanking Dies

The samples shown in the halftone Fig. 1 were procured by me while visiting a brass goods factory and represent the most successful and ingenious pieces of this type of die work that I have so far seen. Fig. 1 shows pieces of the stock of

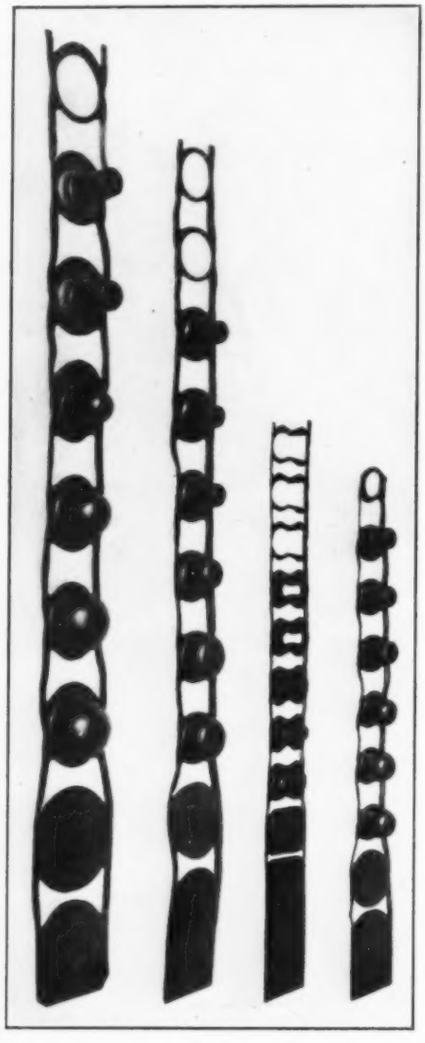


FIG. 1. SAMPLES OF PROGRESSIVE DRAWING

four different pieces all made by the same process, three of which are made in eight stages and the smaller piece which is a lock escutcheon in seven stages. The larger piece shown in Fig. 1 is of sheet steel 0.020 inch thick and the draw is 7/8 inch deep. It is remarkable to make as deep a draw as this at the rate of 150 per minute progressively without annealing, for not only must the tools be made correctly but the stock must be suitable. The other three pieces shown are brass of about the same gage as the steel mentioned.

All of the dies are used with a roll feed. Fig. 2 shows the dies for the second largest piece shown in Fig. 1. Fig. 2 is not to scale or in proportion, but is merely to show the general principle on which the dies are made. They are of the sub-press type and must be accurately made. The lower half contains the perforating die marked *A-1* and the seven punches marked *B-1* to *H-1*. The top half contains the perforating punch marked *A* and the seven dies marked *A* to *H*. The end view of the upper half partly in section in the center of drawing die *B* shows the automatic knockout marked *M*, one

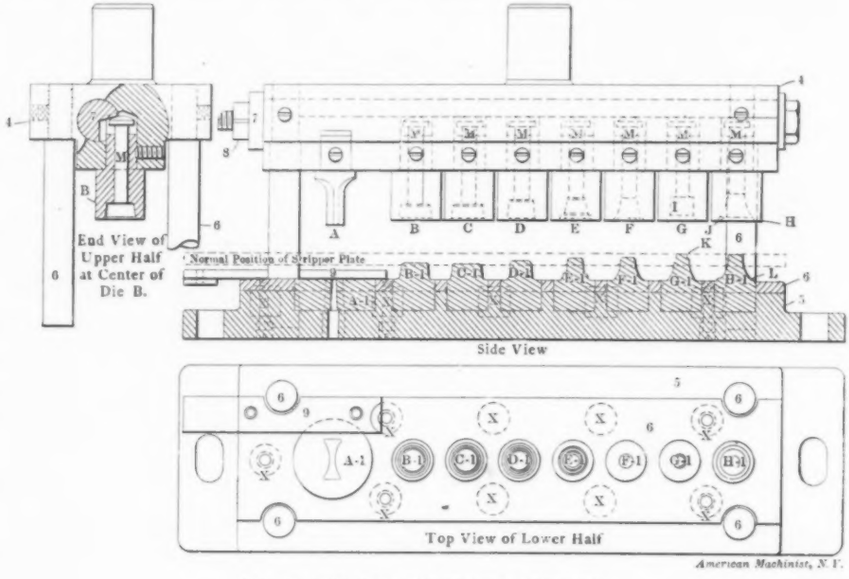

End View of Upper Half at Center of Die B.
Normal Position of Stripper Plate
Side View
Top View of Lower Half
American Machinist, N.Y.

FIG. 2. DIES FOR PROGRESSIVE DRAWING

of which is in every die from *B* to *H*. These are actuated by the round rocker bar marked 7, the shape of which is plainly shown in the sectional end view. This rocker bar is actuated by a lever not shown which is fastened at 8 on the bar 7. This lever is connected to the press bed by a rod fastened at the proper point, to give it its movement on the upstroke of the press. At the first stroke of the press the strip of metal is perforated by the die marked *A-1*. The second stroke repeats this operation, leaving a round blank, still fastened to the stock by the two side members which are plainly shown in Fig. 1.

The object of these perforations is to put the stock into drawing shape to avoid the buckling which would otherwise make this job impossible. The third stroke makes the first draw by the punch *B-1* into the die *B*. The drawn piece is stripped from the punch *B-1* by the spring stripper marked 6 and positively ejected from the die *B* by the ejector *M*. In the fourth stroke the first draw goes over the punch *C-1* while *B-1* is making another draw, *C-1* and *C* are identical in size and shape with *B-1* and *B* and herein lies the secret of the success of the whole job. They start off the register for the succeeding operations right and keep it so. *D-1* is the second drawing punch. *E-1* and *F-1* are the succeeding ones. *G-1* is the perforating punch which acts with the die *G*. The plugs are ejected by the ejector *M*; *H-1* is the final blanking punch which completes the operation.

They use these dies in an inclined press and on brass run them as near as I could judge about 200 revolutions per minute. The spring stripper plate 6 rests normally above all punches as shown by the dotted lines in the side view. In the top view of the lower half the stripper plate is raised by the springs held in the depressions marked *X*. I consider the steel piece shown a remarkable draw. The superintendent of the works said that it could be accomplished only by using a special lubricant. This lubricant is made of fish oil and white lead. He did not state the proportions, but knowing the ingredients it would be easy to find the proportions by experiment.

Grand Rapids, Mich. F. C. MASON.

Indexing Device for Notching Work in the Punch Press

The halftone, Fig. 1, shows an internal notching device with adjustable index finger for interchangeable electrical-motor blanks. The construction is shown in the line drawings. In the core-building department there was always a lot of expense in filing the core slots, and to overcome this we made an adjustable index finger on our notching device, to make the blanks reversible. The blanks are located for notching by a standard key and keyway, and the first notch in the blank must always be in line with the key, or it will not reverse. Now it accidentally happened that the notch on the index ring was not in the right relation with the key in the set edge, and the blank would not reverse. It does not now matter in what position the index ring is fixed to the set edge; with the adjustable index finger here shown we are able to bring the first notch central with the key of the blank.

As shown in the plan, Fig. 2, the table

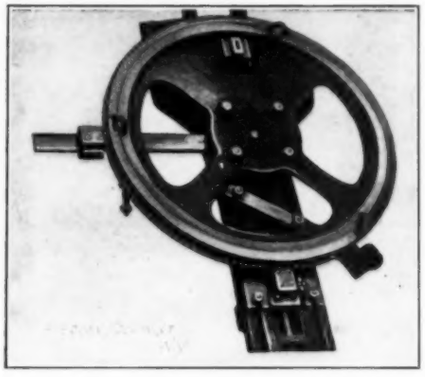
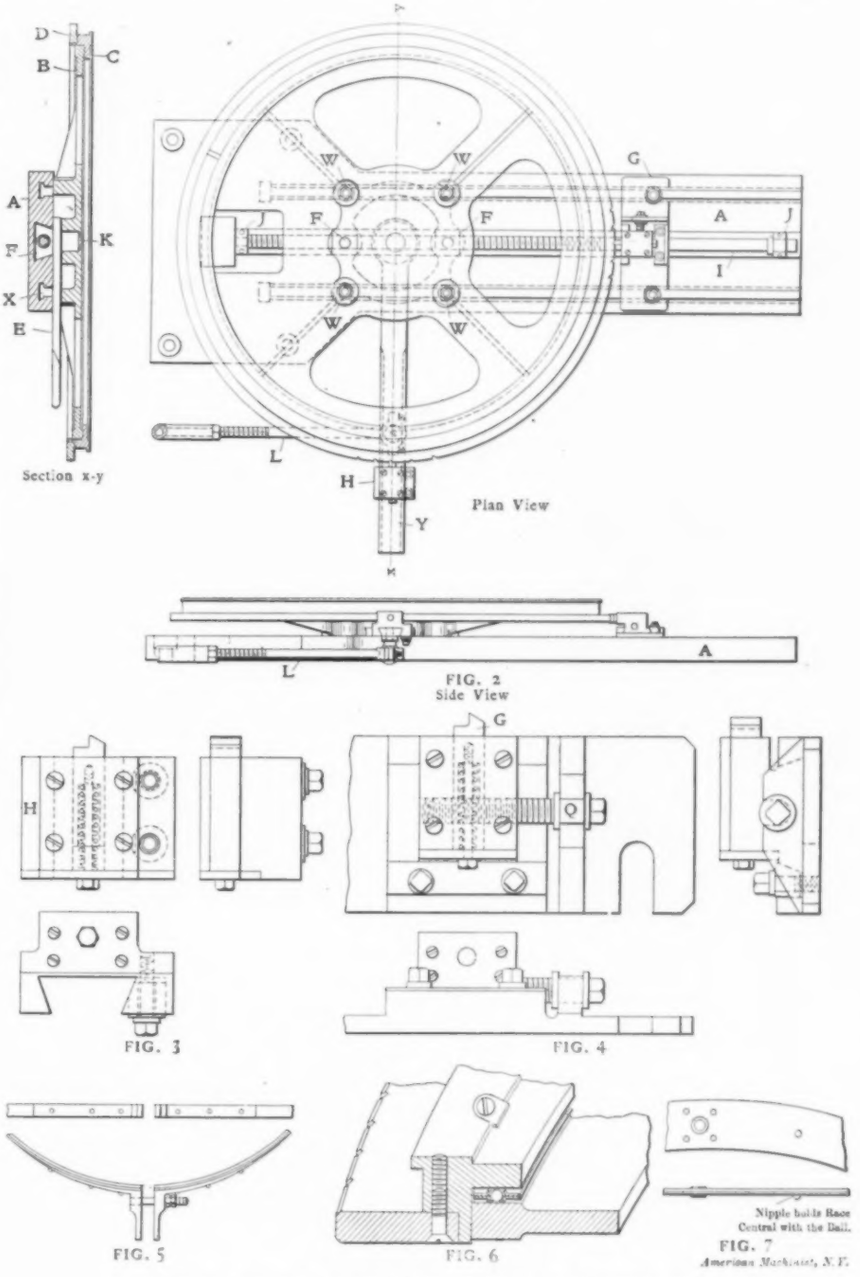


FIG. 1. INDEXING DEVICE FOR NOTCHING WORK IN THE PUNCH PRESS

A, which carries the notching device and can be fixed to any suitable power press, is of cast iron, the top, bottom and dovetail slide are machined and in the dovetail guide are two nuts with studs *F* that carry the spider *B*, which is of cast iron, machined and bored to fit the set edge or ring *C*, the lever *Y*, two studs *F* and the four bolts *W*. The screw *I*, which is of machine steel, is carried by the bearings *J*, and moves the spider *B* to and fro. When in proper position the latter is tightened by the four bolts *W* that move in T-slots *X*, the two bearings *J* are doweled to the tables, the set edge *C*, which is of mild steel and machined to a nice running fit on the outside face of the spider, is recessed to suit the inside diameter of the index ring *D*, and for the outside diameter of the blank to be notched, as shown in the section in Fig. 2. The blank is held down by flat springs, as shown in Fig. 1.

The index ring *D* is of mild steel, machined, and screwed down to the set-edge, and is cut with a given number of notches in the gear-cutting machine. These notches have an angle of 60 degrees. The lever *Y*, which is of machine steel and carries the driving finger *H*, is put in motion by the connecting rod *L*, which is operated by the feed crank fixed to the shaft of the press. The lever *Y* is held in position by the stud *K*, and the connecting rod *L* is fixed by a ball joint to the lever. The driving finger *H* and the adjustable locking finger *G* do not need much explanation, as a detail sketch is given. The block *H* is of mild steel, machined to slide in a dovetail on the lever *Y*, and is locked when in position by two bushes which are clamped with screws to the lever. The operating finger in *H* is of mild steel, machined and case-hardened. It is reversible to drive right or left, is pressed forward by a compression spring, and is held back by a screw, as shown in Fig. 3. The locking finger *G* and its members are of mild steel, and the finger has a cross-adjustment. The finger gets its side movement for adjusting the index ring by screw *Q*, Fig. 4. The body which carries the finger, slides in a dovetail shoe, and is tightened down to the table *A*.



INDEXING DEVICE FOR NOTCHING WORK ON THE PUNCH PRESS

The band brake, Fig. 5, is fastened round the set edge *C*, and rests with its end shoes on a rubber buffer. It is made of a strip of steel, has a layer of leather inside, and two end shoes. It is held together by a screw, which is also used for regulating the pressure. This brake prevents the index ring from receiving too rapid a motion, and thus the index ring is always locked in its proper division.

The ram of the press makes 160 strokes per minute.

All internal notching devices from 3 feet to the smallest size operate on this principle, the heavier ones, that is, over 3 feet in diameter, run on a ball race, as shown in the cross-section, Fig. 6 to take the weight and friction of the set edge. The ball race is formed of two 1/16-inch sheet-metal rings, pierced and flanged to hold the balls, and riveted together. The balls are spaced in the ring at about 3-inch pitch, as shown in Fig. 7.

Edinburgh, Scotland. EMIL KLAPS.

Deciding Which Lathe to Buy for a Jobbing Shop

Your readers may be interested in a test which was run recently for us so that we could decide whether to put in a

THE CHIP

second-hand lathe of doubtful age and accuracy, or a new McCabe double-spindle lathe at about the same price.

The chip shown full size was turned at a cutting speed of 40 feet per minute from a 3½-per cent. nickel-steel bar 10½ inches diameter 9 feet long. The cut was 5/8 inch deep by 0.05 inch feed. In another test a hammered forged shaft 12 inches diameter weighing 6500 pounds was turned at 35 feet per minute with a cut ½ inch deep by ⅛ inch feed. These jobs were comparatively small in diameter. In another shop the lathe was blocked up and a hoisting drum was turned which was about 7 feet long, 5 feet diameter on the flanges and 2½ feet diameter on the body. This job weighed 6200 pounds, and was bored, turned and faced. We figured that the lathe could be kept fairly busy on the 26-inch swing and could take care of the occasional large jobs when they came along.

New Haven, Conn. J. WATT.

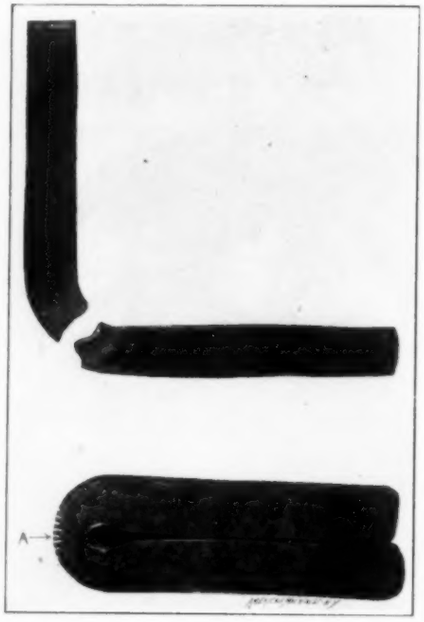
The Physical Test for Steel in the Parker Brothers' Gun Shop

It is seldom that one goes into a first-class shop nowadays without hearing something about the chemist and his work.

Chemistry is a certain science of such uncertainty that I have always been a little dubious about accepting what the chemists tell me, or at least what *some* chemists tell me, for in the same breath they will speak of a certain steel, which had certain properties, while another batch of exactly the same chemical composition showed entirely different properties. This is well known, I think, to all shop men and still many of them pin their faith to steel which contains such and such percentages of this, that and the other. I told you the other day how each bar of high-speed steel is tested in the Ball Engine Works, at Erie, Penn., not by a chemist to find the supposed percentages of *tungsten*, *chromium* and other things, which you and I know only by name, but by the lathe hand to find the actual percentage of the only ingredient he is interested in, i.e., *high speed*. The Parker shot gun is made in Meriden, Conn. I think anyone who knows anything about guns will admit that it is a good gun and I know that anyone who spends the same time that I did in the Parker Brothers' works with Mr. King, the superintendent, as a guide, will admit that the work done on the gun is equal to if not superior to any work done on any shot gun anywhere.

The test of the material used in the Parker gun is of a distinctly practical character, the same as the test of the tool steel in the Ball Engine Works and the proverbial proof of the pudding. The bars ordered for the drop forgings for the frame in which is the lock mechanism are, approximately, 2x2½ inches cross-section. Mr. King tells me he does not care what is or is not in the steel so long as it will stand the following test: The end of a bar is heated to forging heat and drawn out under the hammer to 5/8 inch square by, say, a foot long. The piece is then heated to a good bright red, what would be considered a hardening heat in carbon steel, and plunged into cold water. It is then bent cold on itself, as shown in the illustration. If it breaks, as shown in the upper figure, it is considered too hard and the steel is rejected. If it bends without showing any cracks at *A*, the piece is too soft and is for that reason rejected. If the cracks at *A* extend too far, it is also rejected. An acceptable steel must bend and must show slight cracks at *A*., but not greater than, say, 3/16 inch deep; from this down to 1/32 inch would be acceptable. The bending shows that it is tough enough for the purpose to which it is to be put and the slight cracks show that it is hard enough to machine readily without tearing, but that it is not so hard that it makes the machine and hand operations slow and difficult and the upkeep of cutters, drills and tools a serious consideration.

There were many things which I could not understand about guns before I went into the Parker shop, but which are more clear to me now. I could not understand how a couple of chunks of round steel 2 feet 6 inches long with a 7/8-inch hole through them could cost $100, or more, but I found that a pair of Whitworth fluid compressed-steel barrels cost in the rough from $20 up; that the subsequent boring and reaming, turning on a special forming lathe, grinding on a special cylin-



THE TEST PIECES

drical grinder and many other operations necessary to make a finished pair of barrels are all slow, as compared with the general run of machine work; and even when apparently finished and fitted, the barrels are not safe from the scrap heap.

In one corner of the Parker works there is a tall, clear-eyed inspector. There are no strings on this man or his decisions. All the work and skill which have previously been expended on the gun do not concern him. The polishing of the barrel may be perfect and the action without fault. He, of course, takes notice of these things, but above and beyond these, the gun must do what it is built to do, shoot well and prove its shooting qualities by the pattern it makes. His duty is to inspect and shoot every pair of barrels turned out.

He has a target which runs on a trolley controlled by a belt. The target is painted with white lead and a throw of the belt shifter sends it to the other end of the range. The inspector loads the shell with so much smokeless powder and so much shot and puts it in the gun.

The gun is then secured to a machine rest and sighted by the inspector. I suppose I looked as though I would like to squint along the barrel and in response to the inspector's invitation I did so. I did a good deal of shooting years ago and used to think I knew how to sight a gun. In response to my "that looks good to me" he modestly ventured "a little to the left and low I think, but we'll see," and then he pulled the trigger. It was just as he said, the bulk of the shot tended to the left and low. I would hate to shoot clay pigeons against that man. The inspector after making a pattern goes through the *formality* of counting the number of shot which have struck the target. I say *formality*, for although he does actually count the number of shot he is from long practice able to guess within four or five the number of hits. His guess on one target was 230. The actual count was 234; on another 260, and the actual count 261. In this same department, near the machine rest, are barrel-reaming machines, so if the barrels don't pass inspection they are re-reamed until they do or until he condemns them to the scrap heap which they reach only by way of a power shear where they are chopped into small pieces.

Another item of expense in a high-priced gun is the stock. Fancy stocks cost in the rough from $12 up and $20 is not an unusual price for a rough stock of English or Italian walnut.

Regarding the mechanism of the gun. I saw one among the number which are kept for exhibition purposes which has in place of the steel locking bolt one made of hickory wood. This gun has been shot for 10 years, I am told, with this same wooden bolt and without any accident.

The design of the Parker hammerless gun embodies a particularly commendable feature. A great deal of shooting is done during cold weather and it is a well known fact that tempered steel or, for that matter, any steel is much more brittle in cold than in hot weather. Most of the best shooting is at a distance from civilization and gun shops. The usefulness of the average gun depends on its springs. With a broken spring the average gun is either partially or entirely disabled. Not so with the Parker. It contains no spring which can be broken which would prevent the gun from being used. All parts actuated by springs with the exception of the hammer could be caused to do duty by a push of the finger. The main or hammer springs can be broken in two and will still perform their duty.

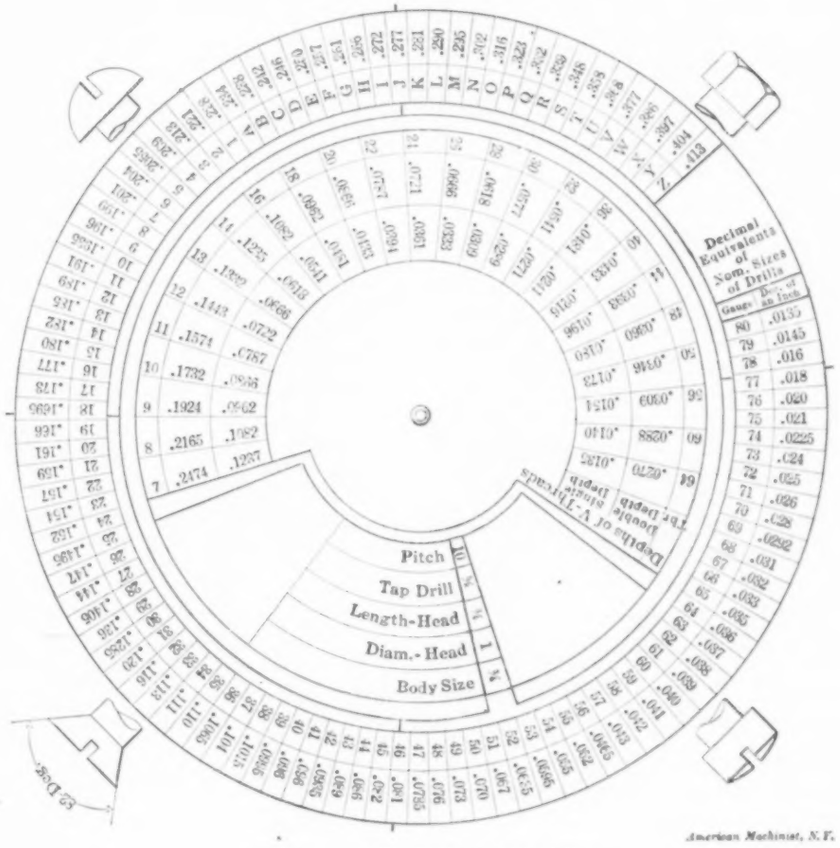
Guns occasionally come in for other repairs and when taken apart it is found that one or both of the main springs have been broken, but as the lock worked all right the owner was not aware that anything was the matter with the springs.

Along with the samples from which the halftones are made came a letter from Mr. King in which he says: "We have had steel of both qualities (the hardest and softest) pronounced by chemists at steel works the same. So much for chemical tests so far as our experience extends. We must test as we have for 25 years, at least at present. We know nothing of chemistry, but do know that the steel enduring the aforesaid tests works all right in our gun work."

E. A. Dixie.

A Handy Machine Screw Computer

Having to use tables of machine screws very frequently and not finding it especially convenient to refer to the regularly printed tables, I made a sort of computer as shown with this, by fastening blueprints on sheet metal.



A HANDY MACHINE-SCREW COMPUTER

The outer circle gives decimal equivalents of nominal size of drills. The table on the center disk gives single and double depths of V-threads from 7 to 64 per inch. Under the center disk are five circles of figures giving the dimensions called for on the disk, opposite each circle. These give the sizes most used in machine-shop work and shows only the size you want, preventing confusion of sizes.

New Haven, Conn. W. J. Warner.

Some striking figures illustrating the growth of the telephone industry are given by the *National Telephone Journal*. These, which are compiled from official statistics, show that there were, on January 1, 1908, roundly 2,160,000 telephones in Europe, 70,000 in Asia, 20,000 in Africa, 65,000 in Australasia, and about 6,390,000 in America (including, of course, Canada, Mexico, and the whole of South America) or, 8,615,000 in all. Supposing the rate of increase to be fairly uniform, there are now about 9,500,000 telephones in the world, of which upward of 6,900,000 are in America, 2,400,000 in Europe, 85,000 in Asia (chiefly in Japan—71,000, India and the Dutch East Indies), 20,000 to 30,000 in Africa, and 70,000 to 80,000 in Australasia. Europe cuts so poor a figure in comparison with America, because several of the most civilized and populous countries are extraordinarily backward in telephonic communication, while it is worthy of note that in these countries the telephone is entirely in the hands of the Government. In the whole of France, for instance, there are less than 200,000 stations, and in Austria and Hungary combined there are actually fewer telephones than in the city of Chicago.—*The Mechanical Engineer.*

Discussion of the Previous Question

Letters from Our Readers Showing How Many Men of Many Minds Look upon Various Subjects Opened up in Previous Numbers

WE PAY FOR THESE ALSO

Strength of Rectangular Plates Supported at the Edges

A problem arose recently in my work in which it was necessary to find the bursting strength of certain rectangular steel plates supported or held at the edges and subjected to a uniformly distributed pressure on one side. The engineering handbooks and textbooks of mechanics and machine design have given very little aid in a solution. In fact the results show a factor of safety of about two for the plate, which is a part of a boiler subjected to high-steam pressure. Can you furnish me with any formulas or equations applying to the strength of rectangular, flat plates under conditions, such as I have indicated.

Simsbury, Conn. A. L. PRATT.

[This question was referred to one of our contributors and below is his reply.—EDS.]

In reply to your query I shall have to say what you, evidently, already know, that the theory of flat plates is one of the least satisfactory of all parts of mechanics. Morley, in his new books, gives quite a complete study of circular plates under different conditions, but when he comes to square and rectangular plates he falls back on some assumptions that are not borne out by anything, and arrives at the same approximate formula that is given by Slocum and Hancock,

$$p = w \frac{a^2}{h^2},$$

where a is one-half the side of a square plate, h its thickness, w the load per square inch and p the resulting fiber stress on a diagonal. Both authors give a modification for oblong plates, but I should prefer to treat any such plate as if one corner would break off at 45 degrees with the side of the plate.

Insofar as a flat rectangular plate fixed at the edges is concerned, the books are dumb. For my own use I have worked up a formula, which would seem to bear on the case, in that it would probably give a factor of safety within reason.

I consider a square plate of side d and thickness t firmly fixed at the edges so that the slope there is zero, subject to a pressure of w pounds per square inch. I assume that it will break on the diagonal. I freeze the part to the left into a cake of ice so that the right-hand part may be considered a cantilever bearing a downward load of w pounds per square inch, an upward pressure under its edges equal to the total load on that side, uniformly distributed along the edges, and a bending moment S per inch of length of the sides which holds the edge level and which I assume to be constant along the length of the edges.

The quantity S is the thing which I want to know before I can figure the stress on the diagonal section. In order to get it I start out as if I was going to find the elastic curve of the beam.

$$M = E I \frac{d^2 y}{d x^2},$$

but I is a variable, at distance x from the point of the beam it is

$$\frac{x t^3}{6}.$$

At this point, then

$$E \frac{x t^3}{6} \frac{d^2 y}{d x^2} = w x^2 \left(\frac{x}{3}\right) - w x^2 \left(\frac{x}{2}\right) + S 2 \sqrt{2}\ x;$$

or

$$E \frac{d^2 y}{d x^2} = \frac{2 w x^3}{t^3} - \frac{3 w x^3}{t^3} + \frac{S 12 \sqrt{2}}{t^3}$$

Integrating to get the slope,

$$E \frac{d y}{d x} = \frac{2 w x^3}{3 t^3} - \frac{w x^3}{t^3} + \frac{S 12 \sqrt{2}\ x}{t^3} + C.$$

Now, $C = o$ because the slope is made zero at the point of the beam. The slope is also zero at the center when $x = 0.707\,a$; which, substituted, gives

$$o = \frac{2 w 0.35 a^3}{3 t^3} - \frac{w 0.35 a^3}{t^3} + \frac{S 12 \sqrt{2}\ 0.707 a}{t^3}$$

or,

$$S = \frac{w a^2}{72 \sqrt{2}}$$

Going back to the familiar expression,

$$M = p \frac{I}{c}$$

at the diagonal of the square we have

$$\frac{w x^3}{3} - \frac{}{2} + \frac{w a^2 2 \sqrt{2}\ x}{72 \sqrt{2}} = p \frac{I}{c} = \frac{p x t^3}{3},$$

or,

$$-\frac{w x^2}{6} + \frac{w a^2}{36} = \frac{p t^2}{3}$$

an expression for p in terms of w at any distance from the point of the beam. Now, p will be greatest when it equals $0.707\,a$. Inserting this value I get,

$$p = \frac{w}{6} \frac{a^2}{t^2},$$

a being the whole length of the side of the square, or if the plate is a rectangle the length of the short side.

There is no doubt that this formula gives values on the safe side since the beam is held sidewise as well as lengthwise. This would not be apt to double its strength, but I should have no hesitation in making the equation,

$$p = \frac{w}{8} \frac{a^2}{t^2}$$

The entire absence of experimental data seems rather remarkable when we think how frequently such construction is used.

Boston, Mass. CON WISE.

Melting of Steel from the Inside

The real true meanings of those great proverbs: "Things are not always what they seem;" and "There's many a slip 'twixt the cup and the lip" were never more forcefully illustrated than by the halftones, on page 972, showing two pieces of iron scale.

It is a well known fact that the melting point of iron scale is very high. It is also well known that if there is too much oxygen, that is, too much blast introduced into a furnace the metal will oxidize. These illustrations show just such conditions. The pieces scaled on the outside and the metal next to the scale melted and ran out through cracks in the scale, just the same as lead when melted will run through a crack in a ladle. There is nothing new or wonderful about it except to the man with a theory and without experience.

With properly regulated blast I defy any man to produce the results stated in the third paragraph of the first column on page 973. Regarding the last paragraph of the same column, if what has been stated is true, then I claim the right to proclaim myself as an "energetic progressive person." Manganese steel safes are now made in the foundry. The bodies of these safes are cast in one piece. Manganese steel is notoriously difficult to cast, especially where there are cores. Why not cast solid blocks and melt them from the inside? The field of application is wide from tin cans to boiler shells, or in

fact, one-piece boilers. That my name may live I give this to the world.

New York, N. Y. E. A. DIXIE.

Accuracy—A Comparative Term

N. H. Homer in commenting on Entropy's "Accuracy—A Comparative Term" writes that the small-shop machinist, knowing where the piece he is working on is to be placed and the function of said piece, is better able to determine the degree of accuracy required than the man in the large shop who has only a blueprint to go by.

As a machine-tool demonstrator I have been in a great number of shops and have been enabled to see the various degrees of accuracy required. In most large shops all blueprints, showing the piece to be machined or otherwise worked on, give limits of accuracy for the various sizes. For example, a hole may be marked 1 inch + 0.0005 inch while the shaft which is to turn in the hole is marked 1 inch — 0.0005 inch. If both hole and shaft were machined to the limiting sizes there would be a difference of 0.001 inch, which, while not affecting some work, would be very objectionable in many classes of machinery.

In the small shop the hole would have been finished first and the shaft fitted to it. If a workman fits a shaft to a hole, or if he finishes both hole and shaft to drawing size there ought to be no difference in the finished product. All small shops do not go to the trouble of fitting the shafts into the holes they will run in, but many of them do, which shows that ideas of successful operation of machinery vary according to the views of different men.

The above is the foreword of what I wish to write regarding machinery methods in a certain shop in Ohio. This firm is of the old school which believes that the man working at the bench or on the floor, can straighten out the errors of machine work with his file or scraper. It is not considered out of the ordinary for a workman to remove 0.015 inch by hand from flat or cylindrical bearings. Of course, a file is generally brought into play first. The firm insists that all tool marks must be removed from the work.

If the planer hand does not have his finishing tool set square with the work and one corner cut deeper than the other, one can readily see what a job it is to remove the tool marks from the piece planed. Also, if the man doing the boring had a sharp-pointed tool and used too fast a feed, the work would look as though a fine pitch thread were cut on it. There is no premium or piece-work system in vogue; the poor machine work is caused by the firm's insisting upon the workmen getting the work out quickly and without bothering about a good finish, because "the file and scraper can take out the bumps." While the finished product is up to standard, it could be made much quicker and more profitable if better machining methods were in use.

Although I have taken this shop for an example there are many others throughout this country using the same obsolete methods, which are time and profit killers. It does seem odd that some shops cannot get work out quickly without much hand work whereas the other fellow doing the same class of work gets it out quickly and profitably. In many shops to speed up the machines means an impairing of accuracy, while other shops are not so affected. One workman when told to "speed up" will lose his effectiveness as a reliable workman, while another will do a good, quick job.

The premium system has demonstrated that a good workman can and will do twice the amount of work he formerly did, and that without impairing the accuracy of his product.

In conclusion it might be said that the methods in use have much to do with the accuracy of any shop's product. Of the many "shop systems" in use one may bring greater effectiveness while another may be detrimental to the very existence of the shop.

Cincinnati, Ohio. ERICH HAMMLER.

Learn to Do the Difficult Things

After reading the paragraph at page 791 under this heading I begin to wonder what hope there is for some of us duffers who were so unfortunate as to be born with silver spoons in our mouths and from fond but foolish parents. There are quite a few who did not have their adversities when they ought and as a general rule they seem fated to lose all that is left to them before they get on their feet. This having to go to bed rock is fully as disagreeable and difficult a process as in putting in the foundations for an office building. One of my friends has just told me the story of his narrow escape. It may be interesting.

"As you know, I graduated from college with no honors but not at the absolute bottom of the class, which was no great credit, however, when you look the class over. I wanted to get a job away from home but *pater* said he had paid for my education and he wanted to see something coming back. He had me stand round the shop in the way for a month or so and then started me out to get acquainted with his friends. My ostensible purpose was selling machinery, but father had a little sense of humor even if he did conceal it. While I was out on this trip he was caught in a railroad wreck, and I had to come home and take hold where he left off. I realized that I did not know much about the machine business and I certainly had little taste for it.

"Jenkins had been office man for years. Father had kept him along, though he was always threatening to fire him. I found it easier to let him run things than to look after them myself. In fact by the time I got around to attend to anything I found he had already seen to it. Things went on for a couple of years before I began to sit up and take notice. About that time I seemed to be signing more and more notes and the president of our bank who was a bosom friend of our family took pains to warn me that there must be something wrong. I disliked his meddling but he had an uncomfortable amount of our paper so I could not very well tell him so. I determined to stick a little closer to the shop and see what I could see." As the first step to sticking close I went over to see Dan Brant, the fellow that dropped out of our class in the sophomore year and now runs the pump shop. I told him my yarn. He told me that the best thing I could do was to go out and watch how fast his men ran their tools and how much they loafed between jobs and then go over and look around in my own shop. He said my men would not speed up because they knew that I did not know. He also suggested that possibly my sales expenses would bear watching for overcoats and jewelry.

"I took his advice; it was an eye opener all right, but my foremen all declared that there was no use in protesting; the men had always worked that way and we had always made money. If I could loaf all the year round on the profit that I was getting out of them why should they speed up? I could not loaf any more than I did, for there was no way of lengthening the year. Well! that was pretty straight talk, but there was truth in it. I reformed. I had to. I was just about where I could sell out at auction and pay my bills or if I could hold the thing together I would continue to be called rich. I sized it up that in a small concern no one would work harder than the man in authority did.

"Since then I have at least made a show of working pretty nearly all the time. When I began to insist on working there had to be something for me to do, and when I began to do something I began to find that I could get others to work for me. There is really no inborn hatred of work prevalent in our men, it is only the lack of leadership that leaves men without ambition to push ahead, or perhaps without really knowing what to do. I pulled out of the hole but it was a close shave, but this one idea was worth all it cost."

Springfield, Mass. ENTROPY.

In 1908 there were 4224 deaths from industrial accidents in the United Kingdom, a decrease of 250 deaths as compared with the previous year. Of the total there occurred 148 deaths from accidents in the industry of metal manufacture, which was a slight decrease compared to the last year.

Making Steel Balls for Ball Bearings

A Mechanical Device Well Known to the General Public, but About the Making of Which There Are Many Hazy Ideas Entertained

BY SNOWDEN B. REDFIELD

There are probably more erroneous ideas on the subject of making steel balls than on any other of the more familiar products of manufacture. This is so because ball bearings are so very widely used. The modern sewing machine employs them in several places to insure easy running; the familiar roller skates are also provided with them, harvesting machinery, lawn mowers, line shafting, are using them; and, of course, the bicycle and the automobile have had them from the beginning of their introduction. These many uses make the ball bearing a familiar article in the popular mind, but as said, their true method of manufacture is more or less a mystery to most of the users. Having heard that lead shot is made by dropping melted lead from a tall tower into a water bath and combining this piece of information with the fact that ball bearings are round, something like shot, the idea that steel balls are similarly dropped in a melted condition has a wider range of belief than is generally realized.

The Grades

The manufacture of steel balls is very interesting and involves a considerable number of processes. From the very nature of the work required of them balls have to be in sizes accurate to an exceedingly small margin, the accuracy required depending upon the class of service for which they are to be used. The different uses and the different degrees of accuracy, which necessarily result from a process of manufacture in large quantities, make it necessary that steel balls should be in several grades. The Standard Roller Bearing Company, of Philadelphia, grades its product in four degrees. What this company terms its "Standard Alloy" is the finest grade which it manufactures. These balls are made of a special alloy of steel, which produces a ball from 25 to 50 per cent. greater in crushing strength than ordinary high-carbon steel. These Standard Alloy balls are used for automobiles and the best grade of high-pressure work and do not vary over 0.0001 inch plus or minus in sphericity or size.

The next lower grade is known as the high-duty ball. It is made of high-carbon crucible steel and is used for high-speed machinery, engines and motor shafts, thrust bearings and general machinery uses where severe service will be encountered.

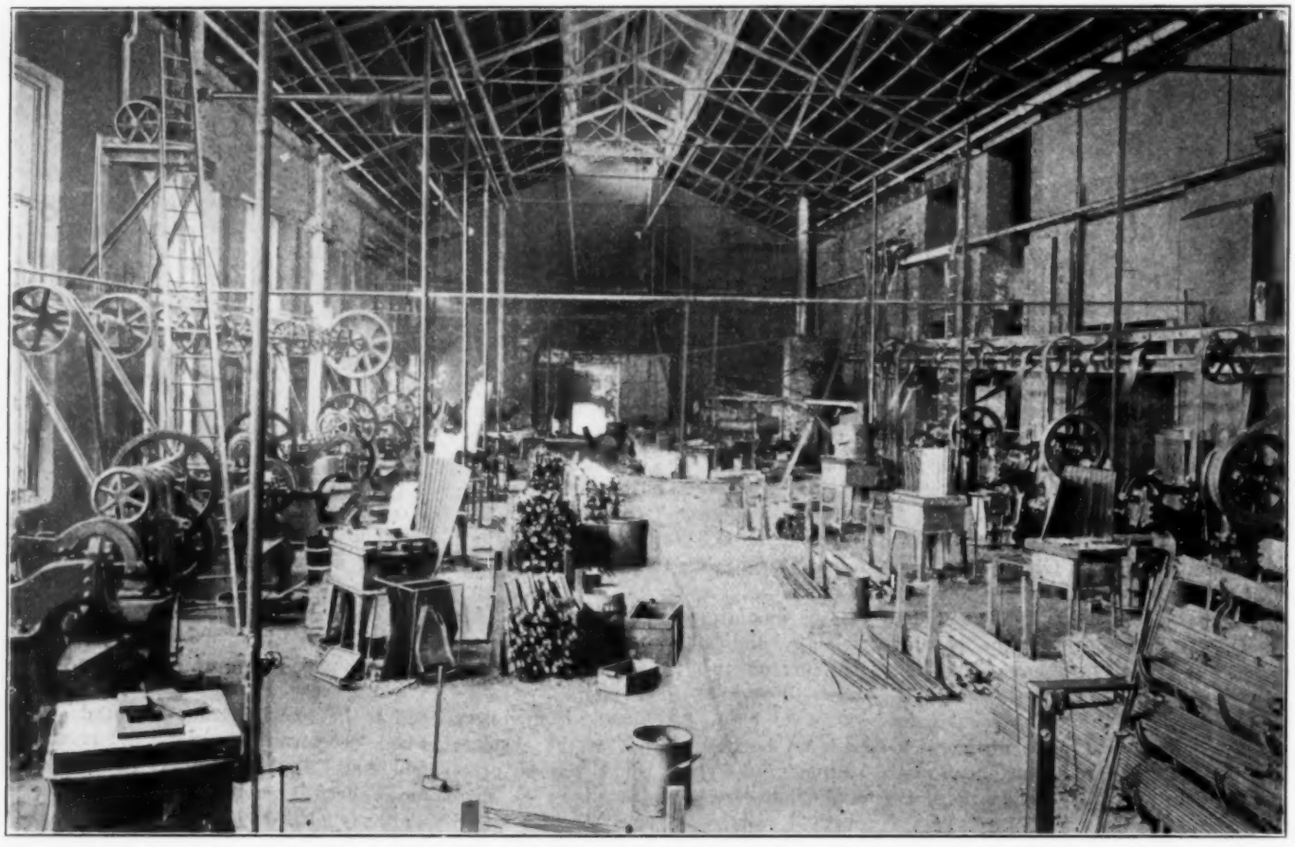


FIG. 1. BALL FORGING HAMMERS, STANDARD ROLLER BEARING COMPANY

The next grade is known as A, or first grade. These are made of tool steel, accurately finished, and vary not more than 0.001 of an inch, plus or minus in diameter.

The B, or second-grade, balls are seconds from the higher grade and vary from 0.001 to 0,002 of an inch, and may have slight defects in their surface.

The lowest grade, C, or hardware, ball is made, or rather selected, from all the different grades, but they vary in diameter

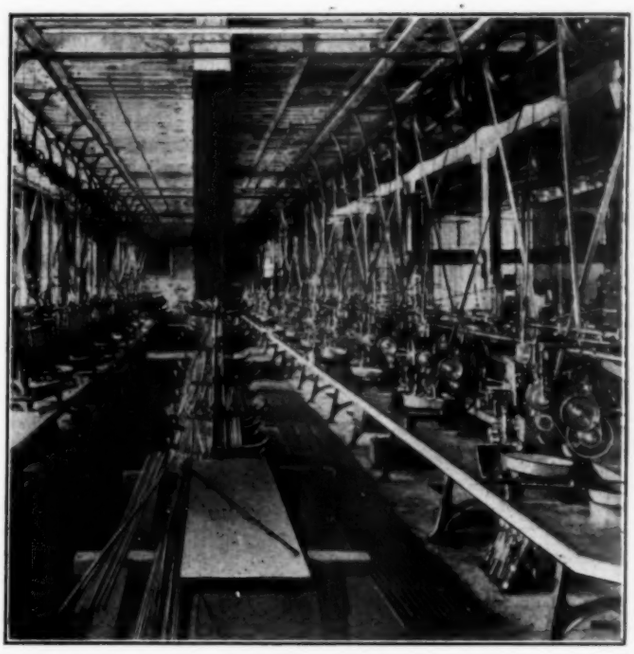


FIG. 2. AUTOMATIC BALL-TURNING LATHES

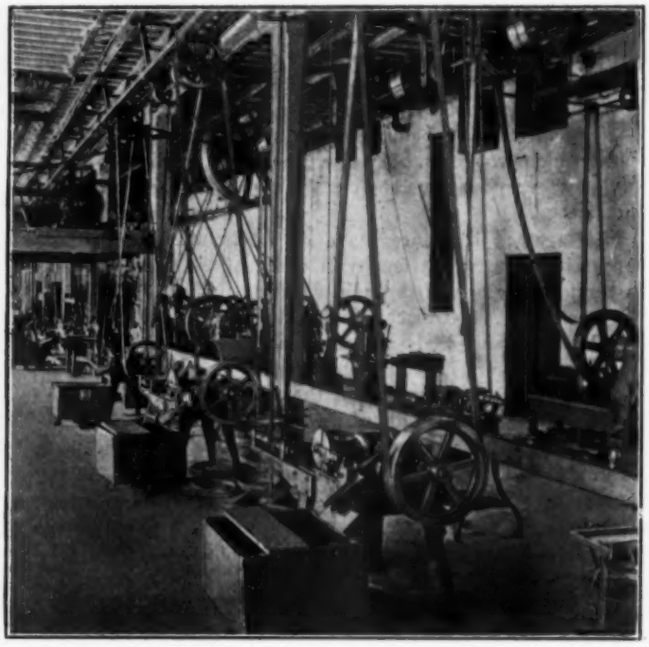


FIG. 3. WIRE-CUTTING MACHINES AND BALL PRESSES

to a greater extent than the better grades, and are really what would be thrown away if there were not considerable demand for this kind, for the purpose of tumbling nickel-plated work, cheap jewelry, etc., to give them a high polish. It is accomplished very easily, quickly and inexpensively, when using balls in this manner.

The Forming

The Standard Roller Bearing Company makes steel balls in three different ways. In sizes from 3/8 inch in diameter and upward they are forged. This is done with a power helve hammer, which forms two, four, or a dozen balls on a red-hot steel bar, the number depending upon the size. The smaller the ball and the rod from which they are forged, the more there are forged at one operation of the hammer. When the forging process is finished, the red-hot bar has been transformed into a series of balls fastened together by short necks of small diameter between them. This row of balls is then put into the trimming press, where the whole row is forced through a series of holes, one to each hole, thus trimming off the fins and necks and separating the balls into individuals, which drop into a box underneath.

For the smaller sizes, that is, up to 3/8 inch, there are two methods of manufacture, depending upon the material out of which they are made. The most interest-

FIG. 4. DRY GRINDING MACHINES

ing of these two processes is that of stamping. The other method of manufacturing these small sizes is simply an automatic turning lathe proposition, where the balls are turned out of the solid bar, the feeding and turning being entirely automatic, which process is, of course, familiar to almost every machine shop at the present day.

The stamped balls are made of steel wire. The wire, which comes in coils, is first automatically run through a cutting-off machine. This machine straightens out the coils and feeds the wire into a cutter, which cuts it off in lengths probably five times the diameter of the wire. The little lengths of cut steel wire are put into a small hopper on a stamping machine. By the rising and falling of this hopper the little wire pieces are fed, end to end, down a tube, at the bottom of which is a moving carrier. This carrier grips each short piece of wire in a pair of fingers and swinging around, carries it over to one side, where it is placed under a press, which simply squeezes the wire into the shape of a ball corresponding to the size of two hemispherical depressions in the upper and lower dies used in the press.

Rough Grinding

By both the forging and pressing operations the balls formed are, of course, in a very rough state, and the turned ones, while more accurate, are also far from finished. All the balls from these three forming processes are next taken to the rough-grinding machines. In these machines the balls of one size are arranged in a circular race, and against them there rotates a circular dry grinding wheel. The circle of the grinding wheel is set slightly eccentric to the circle of the ball race, and as the race revolves in one direction and the grinding wheel in the other their relative motions, together with the slight eccentricity, tend to bring all parts of the ball surface against the grinding wheel as the different parts rapidly revolve. This preliminary grinding is entirely dry, and the product of these machines is a rough-ground ball, which, while still far from finished, is much more accurate than the forged, stamped and turned balls, which were delivered to the machine. The ground surfaces have a scratched appearance almost resembling very bad hand scraping, if this could be done on a spherical surface.

Hardening

After the preliminary dry grinding the balls are taken to the heating furnaces. These furnaces are gas-fired and are constructed with interior guides, arranged to form a spiral. The furnaces themselves are made to revolve, and the balls being fed into the cold end of the furnace and carried gradually forward by the rotation of the furnace and the spiral guides, are gradually brought up to a high temperature, and finally dropped out of the end of the spiral into a water bath. The water bath is arranged with deflecting guides to insure that the balls are brought into intimate contact with the water as quickly as possible by the breaking up of the thin layer of superheated steam that would be formed around the smooth spherical surface if it were dropped straight into the water. This heating and cooling, of course, hardens the ball, and this hardening is purposely delayed until after the first rough grinding, so that the removal of the skin surface formed by the forging and pressing processes would not have a tendency to spoil the hardening. The hardened balls are taken to another set of dry grinding machines where the first grinding process is continued; only now the machines are working on hardened steel instead of soft, as in the first grinding.

In all the stages of grinding the workmen are guided by micrometers, and they gage their work as the grinding progresses by careful measurement of sample balls picked from the lot. The workmen have certain limits of measurements to which their individual product must conform, and when the balls have been reduced within this limit of diameter, they are passed on to the next process. The grinding machines are also provided with an indicator showing the degree of grinding in magnified form.

Oil Grinding

After the second dry grinding the balls which are now rounder and smoother than before are taken to the oil grinders. Here they are arranged in a circular race in the form of a V-groove in a cast-iron ring. On top of the circle of balls is pressed another cast-iron ring having a rounded groove. In the grooves and between all the surfaces there is poured a mixture of oil and carborundum. The cast-iron rings are revolved at a rapid rate, grinding the balls round and round in the grooves, reducing their diameter and making them more and more nearly round. This action also puts quite a high polish on the balls, especially on bronze, some of this material also, being made by the Standard Roller Bearing Company. In this department the micrometering of the balls is continued until they are brought as nearly as possible within the limit of measurement allowed for any one size.

Tumbling

Following the oil grinding, the balls

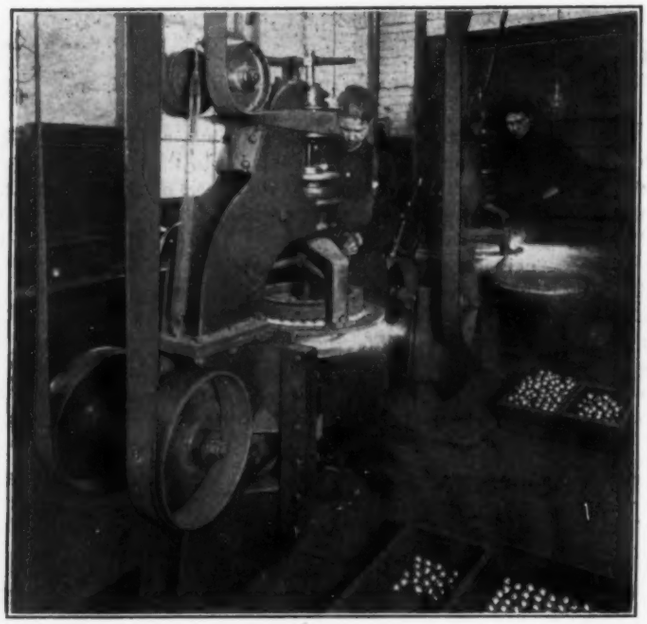


FIG. 5. DRY GRINDING MACHINES

FIG. 6. OIL GRINDERS

are taken to the tumbling room. Here a number of tumbling barrels containing suitable mixtures of polishing material, are continually turning and tumbling large numbers of balls, giving them a finer and finer polish. Between the various tumblings in different solutions the balls are dried by tumbling in sawdust, and some grades are afterward tumbled in barrels with small pieces of leather, in order to give them a higher polish.

FIG. 7. BALL-GAGING MACHINES

Gaging

Careful and accurate as is the process of grinding and the continual micrometer measurement of the balls, they are not all of the same diameter, and it is next necessary to very accurately sort them out in sizes, any one size including all those which come between limiting measurements, the closeness of which depends upon the grade. The larger sizes, that is from ½ inch and upward are micrometered by hand. Rows of girls pick these out one by one and measure each one separately with a micrometer on several diameters and throw them into rows of small boxes before them, each of which contains a certain size between the limits of measurement adopted. This work is very rapidly done, as the operators become very skilful and but an instant of time is spent on each ball.

The smaller sizes are mechanically gaged and sorted. In order to accomplish this they are automatically dropped one after another from a hopper on to the top of an inclined slot. This slot has an exceedingly gradual taper, the slot growing wider toward the bottom end. Underneath the slots there are transverse partitions, which guide into rubber tubes leading to different boxes in the lower part of the machine. As the balls roll down the slot they drop through the slot at a point depending upon the diameter of the ball, the smaller ones dropping through near the top, and the larger ones near the bottom. Those which are too large to drop through any portion of the slot are carried off in a little tube at the far end, and these are used for the hardware or poorest grade. In this way each rubber tube leading to a box conveys to it the balls having a diameter somewhere between the minimum and maximum width of the slot, as it occurs between the transverse partitions leading to that particular tube. The procedure is practically a mechanical method of limit gaging and by suitably spacing the transverse partitions, the limits of diameter for any one size may be made as close together as desired, and thus as many different graded sizes sorted out as desired.

FIG. 8. INSPECTION DEPARTMENT

Inspection

Following the sorting and sizing, the balls are taken to the inspection department. Here a number of girls are employed to pick out by the eye those which are defective. Each girl has a tray with a green-glass bottom, and on this tray she places from 800 to 1000 balls, depending upon their size, in a single layer, resting upon the glass bottom of the tray. She then slips a piece of paper underneath the layer of balls, moving this paper back and forth, which causes them to move around and turn over, and by the skill of her eyesight she very rapidly picks out those which are defective and also by their rotating motion observing if they are out of round. Each girl is provided with a magnet, not unlike a heavy knitting needle, and by means of this magnet she rapidly lifts out the defective balls, which she detects, and by a skilful motion tosses them into the palm of her hand, and now and again tosses all of the defective ones into a box for that purpose. This sorting process, of course, requires great skill, and it is said that girls are much more careful and accurate in this work than men, and their skill and rapidity are certainly most remarkable.

After inspection the balls are counted and as the capacity of the plant of the

Standard Company is 2,000,000 balls per day, it would seem that the question of counting would be a formidable one. However, this is done in trays having depressions holding just so many balls, and by filling these trays, a large number, ranging from 100 up to 1000 balls according to size, are counted at once. The finished, sorted and counted product is then packed in small cardboard boxes and these are packed in larger wooden boxes for shipment.

The balls in each box are alike in size, measuring exact to the size known as "O. K.," or a fraction of a thousandth of an inch larger or smaller, and the contents are so marked on each box. This is to guard users from mixing different lots or sizes together, as by so doing a ball bearing would contain various sizes of balls; in which case, the larger balls only would be obliged to bear all the weight, thereby reducing the strength and efficiency of the bearing.

Balls are made in diameters from 1/32 to 6 inches, and while the greatest call is for the four kinds and grades already spoken of, they are also made of other material, such as brass or bronze, these being largely used for check valves, etc., according to the desire of the customer.

In lauding the functions of chemistry president Bogert of the American Chemical Society pointed out how chemistry has finally pointed the way by which *aluminum* may be obtained cheaply in large amount from its ores. In 1907, our consumption of aluminum was 8500 tons, worth $5,000,000, the world's production for 1907 being estimated as 20,000 tons. The commercial utilization of aluminum and its alloys is writing a new chapter in our mineral industry. To appreciate what this development of aluminum means it is proper to recall that our total supply of it is nearly twice as great as that of iron, and over 800 times that of our copper. Aluminum is already replacing copper for certain electrical purposes. A large part of the power now generated at Niagara is distributed through aluminum alloy cables. It is also used for automobile castings, for airship construction, and for utensils of various kinds.

How To Order Files

That anyone should conceive it to be necessary to waste the space of this paper with an article on the above subject, will doubtless appear strange to many practical mechanics, and yet even they may be benefited by reading the following observations derived from experience.

Every toolmaker knows that to order an assortment of files, merely stating the length, shape and cut, will rarely bring him the file he wants, unless he also specifies the brand, or the maker's name, for there is a difference which frequently amounts to the difference between a file that can, or cannot, be used to advantage.

In the coarser cuts this difference between files is one of workmanship and quality, rather than of shape, cut or size, and two radically different brands may resemble each other so closely that to detect the difference requires a critical examination and practical use. A file, like any other piece of work, usually bears the impress of its maker, and is what his knowledge, experience and individual conception of the work has made it.

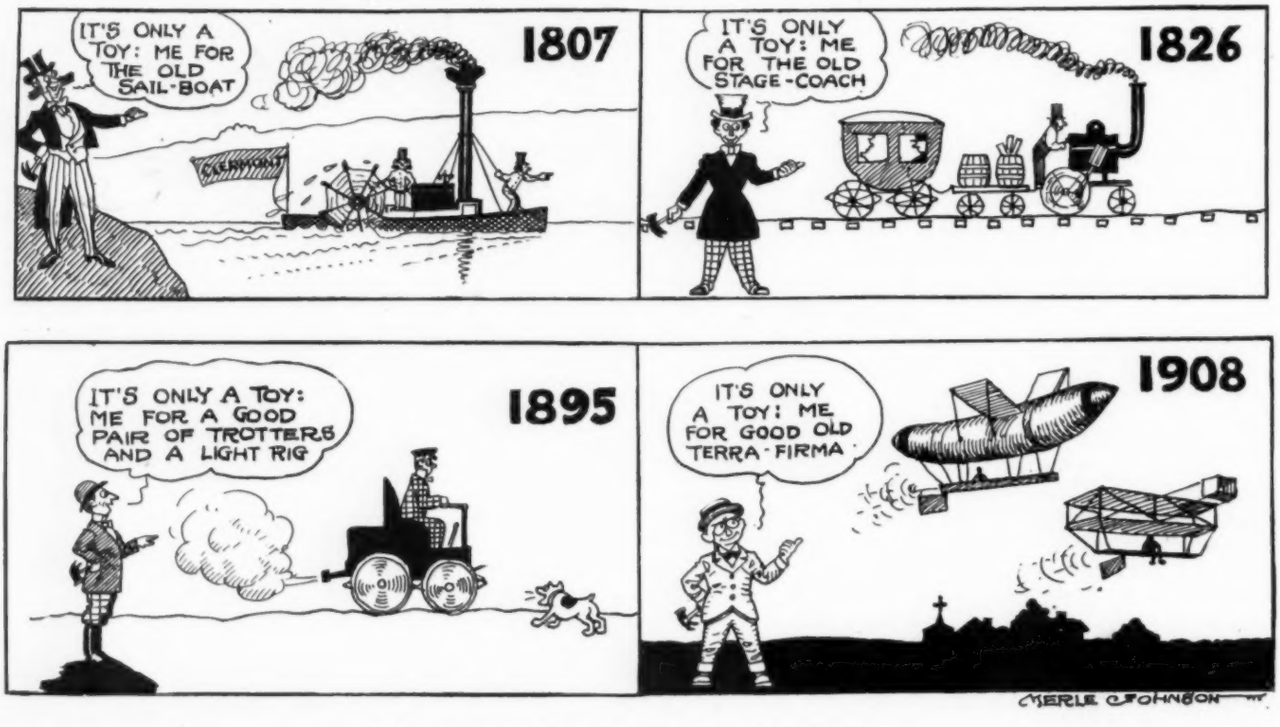
The most marked difference in files has heretofore been found between those of domestic manufacture, and the imported Swiss files called by their makers very appropriately, "Files of Precision," but as the latter kind are now successfully reproduced in the United States, the terms, "domestic" and "imported" have lost their meaning as distinguishing two distinct classes of files.

The ordinary domestic files ranging in length from 3 to 24 inches, are made in five cuts, which are designated as "rough," "bastard," "second-cut," "smooth," "super-smooth," while toolmaker's files are made in sizes from 2 to 12 inches, and in eleven cuts, the cuts not being named, but numbered from No. 000 to No. 8, the first five numbers corresponding, approximately in fineness, that is, number of teeth to the inch to the domestic file, as follows:

No. 000 to rough,
No. 00 to bastard,
No. 0 to second-cut,
No. 1 to smooth,
No. 2 to super-smooth.

Cuts numbered above No. 2, and up to No. 8 have no equivalent in ordinary files.

The exact number of teeth varies in both classes of files, and with the different makes of the same class, but not sufficiently to make the difference noticeable until the file is used, and to avoid mistakes in ordering "files of precision," the order should specify "toolmaker's files."


IT'S ONLY A TOY: ME FOR THE OLD SAIL-BOAT
1807
IT'S ONLY A TOY: ME FOR THE OLD STAGE-COACH
1826
IT'S ONLY A TOY: ME FOR A GOOD PAIR OF TROTTERS AND A LIGHT RIG
1895
IT'S ONLY A TOY: ME FOR GOOD OLD TERRA-FIRMA
1908
MERLE C. JOHNSON

"IT'S ONLY A TOY"—FROM THE NEW YORK JOURNAL

AMERICAN MACHINIST

Issued Weekly by the

Hill Publishing Company

JOHN A. HILL, Pres. and Treas. ROBERT MCKEAN, Sec'y.

505 Pearl Street, New York.

Correspondence on mechanical subjects solicited and paid for. Name and address must always be given—not necessarily for publication.

Subscribers can have address changed at will. Give old and new addresses.

Subscription price $4 per year, postage prepaid, to any post office in United States, United States possessions and Mexico. $5.50 to Canada. $7 in all foreign countries except Europe and British possessions in Eastern Hemisphere.

Hill Publishing Co., Ltd., 6 Bouverie St., London, E. C., will serve all subscriptions for Europe and British possessions in Eastern Hemisphere. Price 30 Shillings for England. For all other countries in Eastern Hemisphere, 35 Shillings.

Entered at New York Post Office as mail matter of the second class.

Cable Address, "MACHINIST," N. Y.
Business Telegraph Code.

CIRCULATION STATEMENT

During 1908 *we printed and circulated* 1,205,750 *copies of the* AMERICAN MACHINIST.

Our circulation for June, 1909, *was (weekly, monthly and European)* 91,250.

July 1	34,000
July 8	19,000
July 15	19,000

This paper reaches 34,000 *separate readers each month and* 19,000 *each week.*

None sent free regularly, no returns from news companies, no back numbers. Figures are live, net circulation.

Contents

	PAGE
Making the Colt Automatic Pistol	95
Attachments for Drill Presses	101
The Panama, a Machine Made Canal	103
A Turret Nurling Tool	110
Milling, Bending and Testing Fixtures	111
An Exhibition of Blue Chip Steel	115
The Vail Family and the Speedwell Works	117
Boring a Jig on the Miller	119
Practical Letters from Our Readers: Progressive Drawing, Piercing and Blanking Dies....Indexing Device for Notching Work in Punch Press ....Deciding Which Lathe to Buy for a Jobbing Shop....Physical Test for Steel....A Handy Machine Screw Computer	120-123
Discussion of the Previous Question: Strength of Rectangular Plates.... Melting Steel from the Inside....Accuracy....A Comparative Term.... Learn to Do the Difficult Things	124-125
Making Steel Balls for Ball Bearings	126
How to Order Files	130
Mechanical Toys	130
Aviation—A Most Difficult Art	131
New Tools and Machine Shop Appliances	132

Aviation—A Most Difficult Art

Optimism in regard to the bright and immediate future of the airship and human flight is prevalent and undoubtedly justly so. The commercialization of the aëroplane is already with us as shown by recent display advertisements in several New York daily papers. It is a serious question, however, if the enthusiasts have considered, or in any true degree realize the difficulties of the aviator's task, or are intelligently planning for suitable instruction in aviation. Such instruction must be forthcoming before any very large number of the human family can feel at home in the air.

Glance backward a few years to the days of bicycle popularity; recall your troubles in learning to balance on the narrow tread of the wheels; remember the bruises and bumps that you carefully nursed on your own body and smiled at if they showed on a friend's. Yet you were only a few inches higher in the air than if you were walking and had no obstacles to consider except uneven places in the street. And these uneven places were plainly in sight.

The automobile driver likewise has a road whose inequalities he can see, and he can easily avoid the ruts and pits that are before him. When driving he is sitting in a comfortable seat, has no balancing to look out for, can operate at a reasonable speed, if he will, and can give his whole attention to his machine and to the road, with the surrounding conditions which he must consider and guard against in plain view. Nevertheless, some acknowledge that they do not have the nerve required to operate an automobile.

How different is the condition of the aviator! His pathway is beset with eddies, swirls, cross-currents, waves, billows, puffs and gusts of wind that he cannot see, that can only be known when he feels them and yet one and all must be carefully reckoned with if he hopes to make a successful flight. All of these things are met at a speed of translation through the air of from 25 to 45 miles per hour. While beset with these unknown difficulties, balance must be maintained in a position at a considerable hight above the ground and under conditions intrinsically far more trying than on a bicycle, and with life the possible price of failure. Again the successful operation of a highly organized gasolene motor must be attended to under the conditions of air disturbances, high speed, elevation and sensitive balancing. Does not aviation call for a high degree of physical courage combined with excellent self-control and cool judgment? Apparently the doing wrong of any one of many things invites disaster.

That the question of balance in the air is in itself a difficult feat is shown by the long experiments of the Wright brothers with gliders, extending over several years, and similar work done by Curtiss and McCurdy. In trying to learn this one phase of the art of flying, both Lilenthal and Pilcher lost their lives. In a professional paper presented by Major Squier to the American Society of Mechanical Engineers last December, we find this pertinent paragraph: "The aviator's task is much more difficult than that of the chauffeur. With a chauffeur, while it is true that it requires his constant attention to guide his machine, yet he is traveling on a roadway where he can have due warning through sight of the turns and irregularities of the course. The fundamental difference between operating the aëroplane and the automobile is that the former is traveling along on an aërial highway which has manifold humps and ridges, eddies and gusts and since the air is invisible he cannot see these irregularities and inequalities of his path and consequently cannot provide for them until he has actually encountered them. He must feel the road since he cannot see it."

Time will, of course, build up a fund of experience that will make certain present difficulties look insignificant, yet for the present let all who contemplate flying realize that the aviator's task is far from being conducted among the light, fleecy clouds of which the poets sing. It is a never-ending source of surprise to us that any have attempted it and still more that any have succeeded.

The dangers are inevitable because of the surrounding physical conditions beyond human control. However, there are other dangerous conditions that can be guarded against. Such are the improper selection and improper use of materials of construction. In automobile development men, who did not understand the use of materials of construction and engineering practice, built machines that would go until they broke down—which was usually soon—yet they actually ran. That was the important fact. At that stage the engineer stepped in, changed materials here and there, strengthened the weak parts, redesigned others, and lo! we have the successful machines of today.

Such must be the story of airship development. Crude design, amateurish workmanship, improper materials must all be superseded by the best that engineering practice can suggest. The tearing of a guy wire from its clip, the snapping of a tow line, the twisting off of a propeller shaft are things that can be almost entirely eliminated from airship happenings, as they or similar accidents have already been from other lines of machinery building. Again a wide field of impractical theories, incorrect principles and improper applications must be threshed over and over again, until accumulated experience shall point out in unmistakable language the road to success.

We await with interest the product of the combined efforts of the airship inventors and their brother engineers.

New Tools and Machine Shop Appliances

Showing New Ideas in Machine Shop Equipment That Make it Possible To Do Better Work at a Reduced Cost

THE LATEST INFORMATION

The Adamite Line of Surfacing Machines

Among the latest developments in the use of cloth-mounted abrasives are the belt type of grinding and polishing machines, three of which are illustrated herewith. These have been developed by the Adamite Surface Machine Company, Newark, N. J., who have been working along this line for several years, and in addition to the machines themselves are introducing the French electrically produced abrasive known as Adamite.

Fig. 1 shows the vertical type of machine equipped with two belts, one for roughing and the other for finishing the material being ground. The adamite belt runs over an endless leather belt, both being independent so far as tension is concerned, and both are supported back of the work, which rests on the table shown in front. These belts vary from 3 to 6 inches in width according to the machines.

In Fig. 2 is a horizontal type of this same machine, having the same characteristics as the first, but is better adapted for some classes of work, which can be best handled by holding down on the belt. It will also be noted that the supporting table is grooved diagonally, which allows air to be drawn in under the rapidly moving belt so as to prevent overheating from constant work. The belt tension is automatically adjusted by the weighted lever shown, which can be set as desired. This machine is ordinarily furnished with a 9-inch belt, but can also be supplied with two 4-inch belts containing different grades of abrasive so as to be used for roughing and finishing by

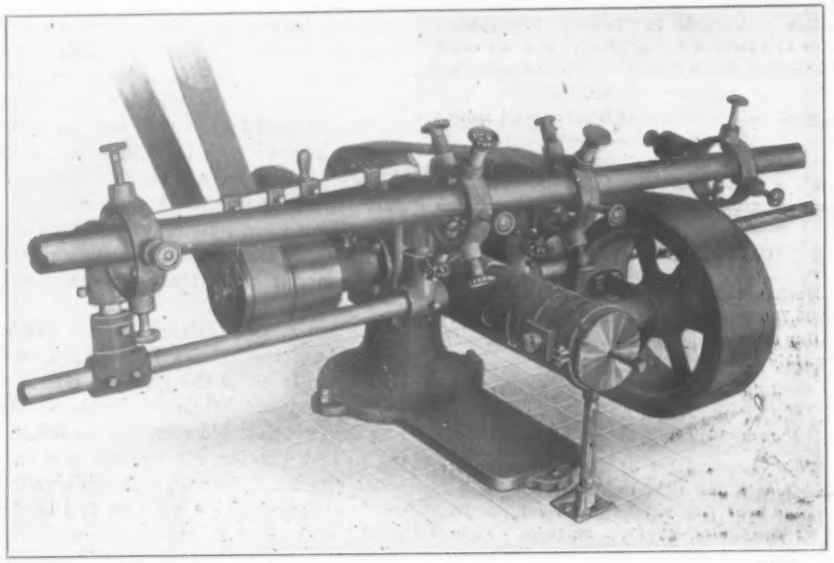


FIG. 3. TUBE- AND SHAFT-GRINDING MACHINE

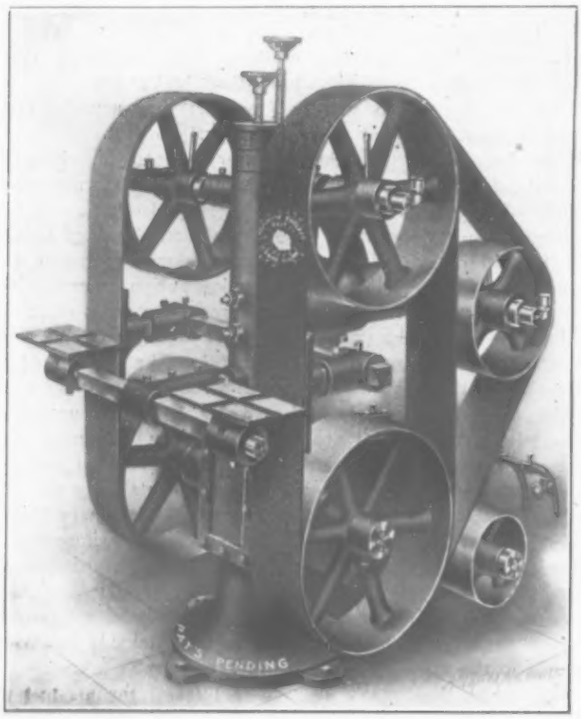


FIG. 1. VERTICAL BELT GRINDER

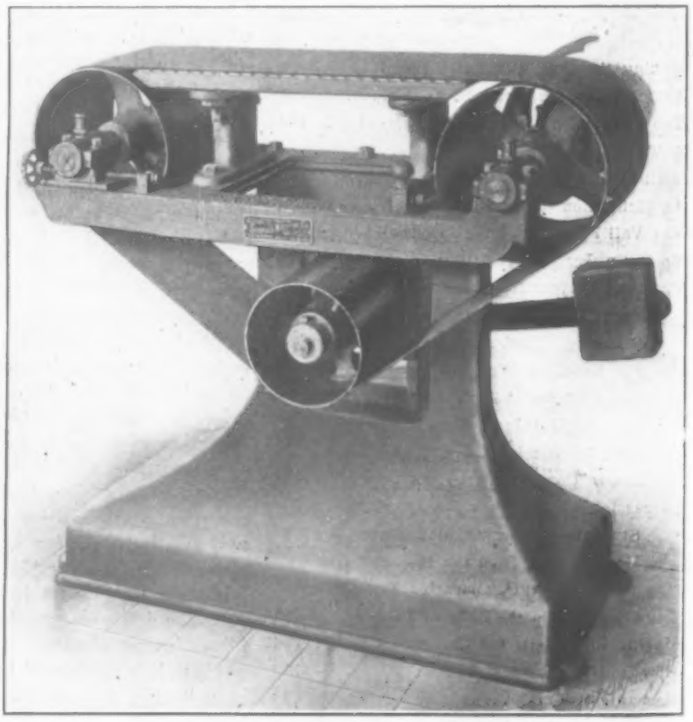


FIG. 2. HORIZONTAL-TYPE GRINDER

passing the work from the coarse to the finer belt.

An interesting application of this machine is shown in Fig. 3, which has been designed especially for polishing tubing, shafting or similar work. The same belt principle is used as before, but the addition of the supports shown converts it into a very convenient machine for doing this work very rapidly. These supports hold the tube at an angle with the belt, so that it is only necessary to place the tube in the supports and start it across the belt, which then feeds it automatically at the same time it is being ground. As shown, the machine will handle anything up to 5 inches in diameter, the supports simply cutting away one side of a 1-inch tube for a distance sufficient to allow for the width of the grinding belt, and then passing the small pieces through this tube. This brings them in contact with the belt, and the remaining wall of the tube gives the necessary resistance. This is also set at an angle so that the pieces to be ground are fed through by the action of the belt itself.

The Modern Plain Grinder

The plain grinder continues to grow in favor as work becomes more specialized and the machine shown is one of the latest

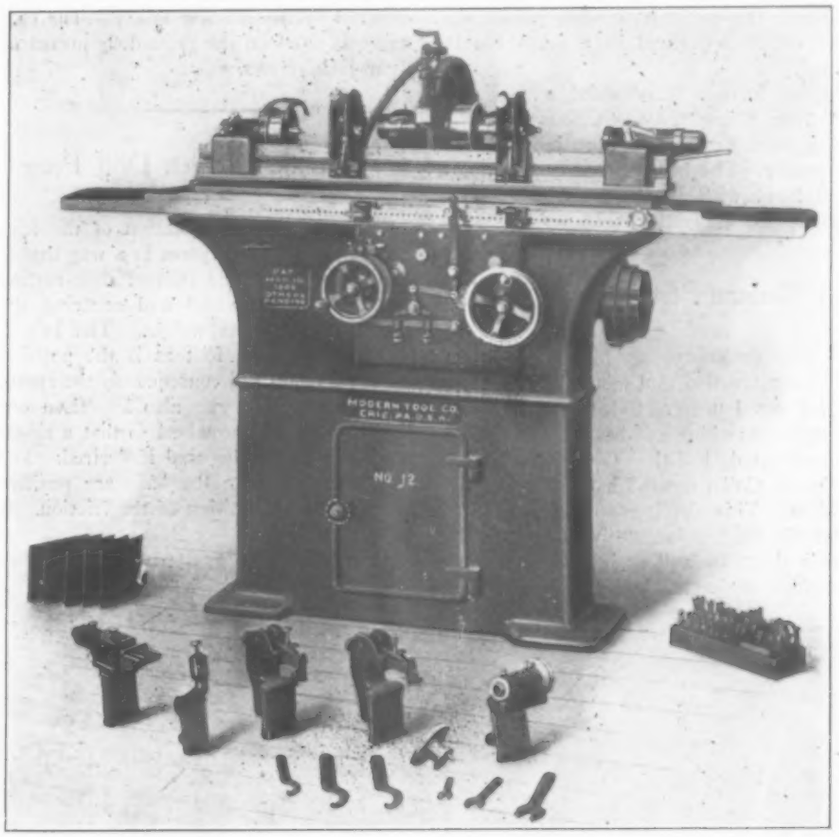


FIG. 1. THE MODERN PLAIN GRINDER

being equipped with a large steel ball at the end of each screw, so that the work turns very freely, and the balls present no resistance to its being drawn through by the angularity of the grinding belt.

These belts run 7000 feet per minute, and as an example of the capacity of the machine for grinding tubing, they recently ground 80 feet of tubing from 1½ to 3 inches, which required four settings of the machine, in 1½ hours. These tubes were ground at the rate of 5 feet per minute, and a single 6-inch adamite belt 10 feet long, of No. 90 grade, finished the whole 80 feet of tubing.

In grinding small tubes or rods a very simple device is used which consists in arrivals in the field. This is the No. 12 of the Modern Tool Company, Erie, Penn. The machine is designed with ample metal to absorb vibrations when the wheel spindle is hardened and has phosphor-bronze bearings. Both headstock and footstock are secured to the vertical rail by the clamping device shown in Fig. 2, the hook bolt engaging on the lip at the back of the rail clamping the front and back as shown. This gives a rigid support directly under the spindle and does away with overhang.

An automatic cross-feed gives a range from 0.00025 to 0.004 inch for each reversal of the table and is thrown out automatically when the work is ground to size. Hand feed is also provided for when desired. The design of the universal rests can be seen from those on the floor in Fig. 1.

It is sometimes necessary to grind up a pair of centers at the time the machine is set up for a taper job and to provide for this, the center-grinding device in Fig. 3 allows the center to be adjusted to give the correct angle regardless of the slide.

This machine will grind straight or taper work up to 5 inches in diameter and

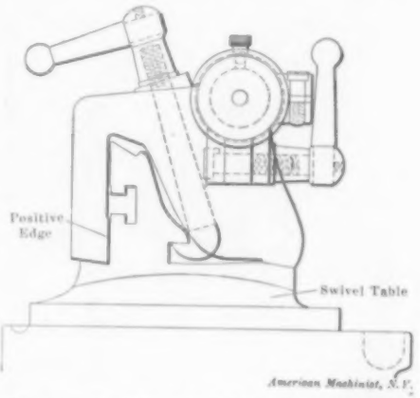


FIG. 2. METHOD OF CLAMPING HEADSTOCK AND TAILSTOCK

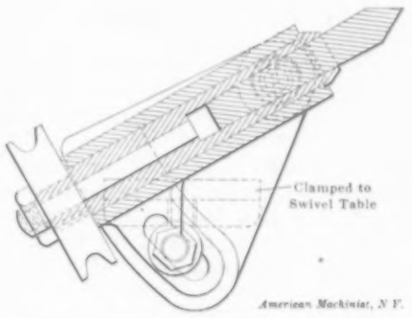


FIG. 3. FIXTURE FOR GRINDING CENTERS

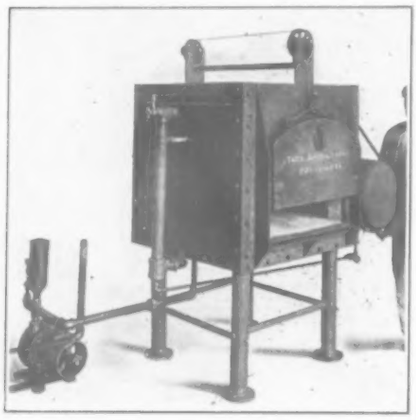
31 inches long, with any taper up to 1¾ inches per foot. It carries a wheel up to 12 inches in diameter by ¾ inch face and occupies a floor space of 41x110 inches, weighing about 2650 pounds.

A Handy Set of Cold and Cape Chisels

Every machinist knows the disadvantages of forging up his own chisels with the intention of eventually getting a set, the usual result being that they are not uniform and that the first one is worn out before he gets the last one made. The Lynn Tool Forging Company, Lynn, Mass., has put out a neat set of tools, both cold and cape chisels, and including a center punch, 12 in all. They are hand forged, of 7/16-inch octagon steel, 5½ inches long, and come in a cloth case with a place for each at a lower cost than most machinists can make their own. The quality of these tools and the neatness of their arrangement will commend them to mechanics.

Oil Burning Steel Heat Treating Furnace

Oil as fuel for steel heat-treating furnaces is used on account of the ease with which the temperature may be regulated and maintained and a large demand for such furnaces led to the development of the one made by Tate, Jones & Co., Inc., Pittsburg, Penn. In this, the oil



OIL-BURNING ANNEALING, TEMPERING AND CASE-HARDENING FURNACE

supply is carried in a tank at the side of the furnace, the tank being filled from a barrel as needed by a small rotary pump.

The furnace is of iron construction with firebrick linings. The hearth or furnace proper is so designed as to permit the reception of either boxes or loose articles —the curvature or arch of the roof assuring the same uniformity of heat in either case.

The oil is forced from the storage tank to the burner, located on the opposite side of the furnace, by means of air pressure from regular shop blast on the pressure blower shown on the floor. The burner, which is of special design, is so constructed that a perfect mixture is assured at all times—the atomizing of the air and oil forming a flame of regular uniform character.

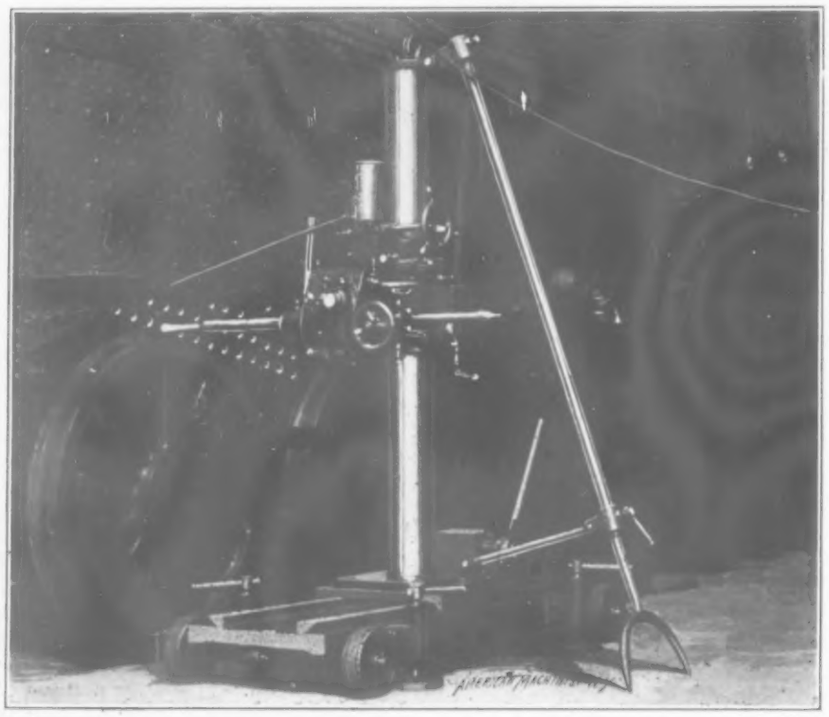
Entering as it does at the center of one side and near the top of the furnace the flame or heat is thrown down, by the peculiar curvature of the roof, so as to secure a uniform temperature at all sections of the furnace. The heat is given an opportunity to circulate entirely around the six walls of the furnace before it can make its escape, as the vent or escape is located in a corner in the roof.

The furnace is provided with a door entirely across the front, thus permitting the furnace to be used to its maximum capacity. The hearth, roof and walls are all lined with the best refractory brick made especially for this work.

A German Portable Drill Machine

The accompanying illustration shows the construction and method of operation of a novel universal electric drilling and tapping machine of the portable type as constructed by the Oerkeugmaschinen-Febrik, Collet & Engl hard, at Offenbach-Main. This drilling-tapping machine is largely used in locomotive works and repair shops as well as in boiler shops for drilling in frames, boilers, and fire boxes as well as in drilling out defective stays. It is easily transported and placed in service without any preparatory work and can often be employed in positions where other drilling machines cannot be utilized to advantage. The drilling spindle is driven by a 2-horsepower motor through the agency of a worm gear and has four speed changes. The head can be turned on the column which can be moved horizontally on the carriage which allows a number of holes to be drilled without moving the whole machine.

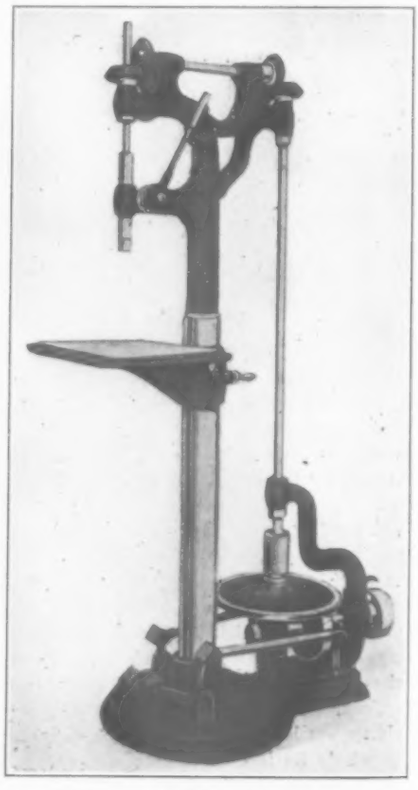
In drilling holes of small and medium diameter, the weight of the machine affords sufficient stability. For drilling larger holes, and when the head works at the top of the column, the machine is secured by the bracing shown. The carriage is fixed on the ground by means of four jack screws.



A GERMAN PORTABLE DRILL IN A RAILROAD SHOP

A Friction Driven Drill Press

This shows an application of the friction drive to a drill press in a way that is a little unusual, the friction disk resting on the driving wheel and securing the friction due to its weight. The belt is controlled by the foot as is the position of the friction and consequently the speed. The friction disk can also be raised out of contact with the wheel so that a single pulley drive can be used if desired. The notches shown on the base are positive stops for each position of the friction. It



FRICTION-DRIVEN DRILL PRESS

is also made with the driving pulley at the side. It will drill up to 9/16 inch and to the center of a 13-inch circle and is made by the Barry & Zecker Company, Lancaster, Penn.

Machine for Welding Aluminum Wire

An aluminum wire welding machine is made by the Cowper-Coles Engineering Company, Ltd., of London, Eng. The aluminum is welded without flux or solder and is especially serviceable for rods, squares and straps.

The metal is brought to a welding heat by a blowpipe using city gas and it is then squeezed together by a spring that moves one of the jaws, which has an adjustable stop. The jaws are lined with a refractory holder, so as to insulate the aluminum. The machine is shown in Fig. 1 and its operation can be clearly seen.

FIG. 2. APPARATUS FOR WELDING ALUMINUM WIRE WITH BENZOLINE TORCH

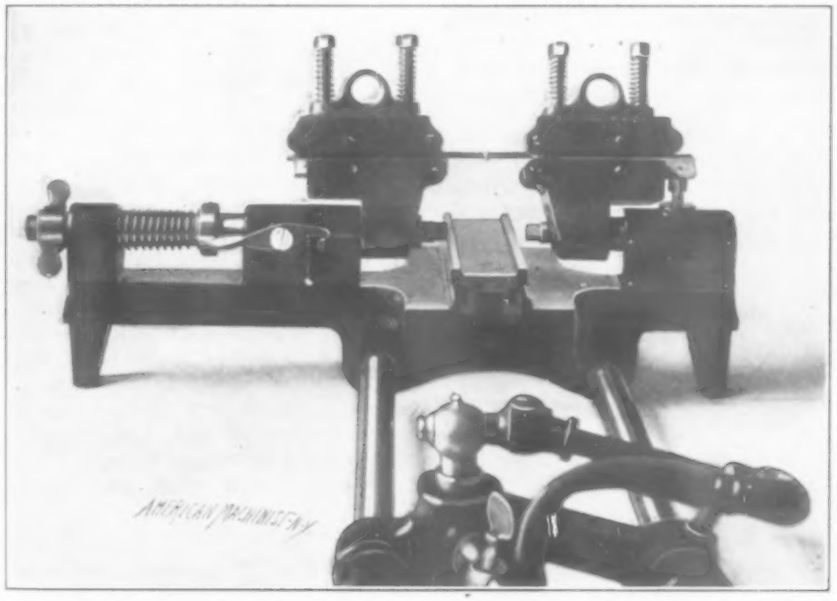


FIG. 1. MACHINE FOR WELDING ALUMINUM WITH GAS TORCH

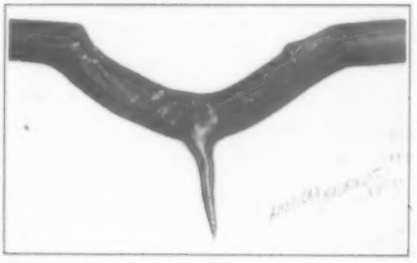


FIG. 3. MOLTEN METAL IN OXIDE SHELL BEGINNING TO FLOW OUT

FIG. 4. BENDING TEST AFTER WELDING

The blowpipe is fitted with a spring universal joint, and can be adjusted in position along the rods, the flame plays on a grooved firebrick that is supported on an adjustable inclined plane, and the hight can be regulated to a nicety, by means of the screw.

The machine can be operated, if desired, by a Dowson producer-gas blowpipe made of iron, or with benzoline lamp for field work, as shown in Fig. 2. It is held that the reduced cost of aluminum has contributed greatly to the rapidly increasing use of this metal, in competition with copper, for electrical purposes, but one of the greatest obstacles to its extended use has been the difficulty of hitherto obtaining a sound mechanical and electrical joint.

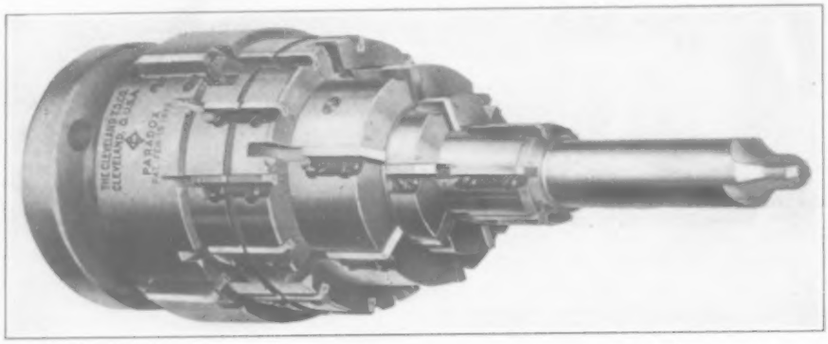
The principle utilized in this process is of interest. It will be noted that the two ends of the rods, to be jointed, are butted together. Heat from a gas blowpipe or benzine lamp is applied at the joint. This actually assists in the formation of an oxide skin, and as the metal becomes fused it is retained within the tube of oxide. When the ends of the rods are in this condition, they are brought rapidly together by releasing a spring catch. The oxide skin, bursting at the point of contact, is driven out by the pressure of the spring and the clean molten metal unites in a perfect joint.

The existence of the bag of fluid metal is seen in Fig. 3; the metal having liquified, has caused the flexible bag of oxide to sag. This has then been pierced and the molten metal has run out. After welding the ring of metal the fin that has been squeezed out is removed and the joint may be tested by bending and twisting, as shown in Fig. 4. The removal of the fin is not necessary where the bur may be no objection.

Combined Boring Tool and Reamer

The engraving shows a very interesting combination boring tool and reamer recently made by the Cleveland Twist Drill Company, Cleveland, O., in which there are eight cutting diameters. It is 6½ inches in outside diameter and 21 inches long, weighing nearly 100 pounds and consisting of a countersink, 5 reamers of

different diameters and form-facing tool at the back. Each reamer blade is of high-speed steel, there being 34 in all, and 12 of these are a combination double cutting type, giving a total of 50 cutting edges if the countersink is included. The body is a casting holding the two upper sets of blades and in this is the smaller body of machine steel in which the next three sets of blades are fitted. This in turn holds the countersink. In use the tool is bolted to the boring head of a large horizontal boring machine, and has proved a great time saver as well as being more economical in first cost than separate sets of tools fitted with high-speed cutters.



A COMBINED BORING TOOL AND REAMER

Novel Socket for "Flatwist" Drill

The increasing use of drills twisted from flat stock has brought the problem of driving them into great prominence, and we illustrate herewith the solution reached by the Cleveland Twist Drill Company, Cleveland, O., both as to the drill and the socket for driving it.

The drill is twisted from flat stock, with the shank forged and ground to size from the original bar, and this shank has a uniform taper on the flat side as well as on the rounded edges. This allows the use of a very strong and very simple socket, which centers the drill perfectly and holds it firmly, with the strain distributed over the entire length of the shank, affording the maximum driving capacity and having no weak point to break or twist.

The whole thing is so simple and its action so apparent, that further description is unnecessary.

FIG. 1. THE PARAGON "FLATWIST" DRILL

Removing 18 Cubic Inches a Minute on a Milling Machine

The removal of 18 cubic inches of stock per minute on a milling machine is something unusual enough to attract the attention of any mechanic even though it be unsafe to label any special the "best ever" in the light of rapid developments of both machines and cutting, and when the material was a steel of 60,000 pounds tensile strength, and the cut was taken with a nickel coin standing on edge at one end of the table and a glass brim full of water at the other, neither being disturbed in the least, it becomes a red-letter performance regardless of what may or may not have been done or will be done.

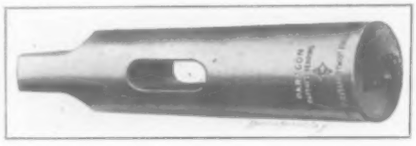


FIG. 2. SOCKET FOR PARAGON "FLATWIST" DRILL

This was one of the stunts of No. 5B heavy, plain, Brown & Sharpe milling machine with a gang of two 3¾-inch cutters. The cut was 3/16 inch deep, 6 inches wide with a feed of 16 inches per minute and a surface speed on the cutters of 60 feet per minute. While the nickel and the glass of water are not part of a milling-machine equipment, they do show an absence of vibration that is rather remarkable even in these days of heavy machine tools, and there is little doubt that vibration has more to do with the destruction of cutting edges than is usually believed. This machine was equipped with a 20-horsepower General Electric motor so that the stock removed per horsepower was 0.85 cubic inch.

There was also a No. 3 vertical machine which removed 9.375 cubic inches of metal per minute with the same cutter speed of 60 feet, a feed of 12½ inches per minute with a cut of ⅛ inch deep and 6 inches wide. This took a 10-horsepower motor and figures out to 0.88 cubic inch per horsepower.

It is also interesting to note that the cutters used on the No. 5 machine removed 1800 cubic inches of steel without regrinding. These cutters had spiral, nicked teeth, and were cut from the solid.

Prevention of Rust on Machine Parts

The prevention of rust on finished machine parts is a more serious problem than might be imagined, and while it does not touch the actual making of machinery, it plays an important part in the marketing or selling end. The old mixture of white lead and tallow has given way to other mixtures, usually less expensive and easier to remove, the latest being known as Vatudrip and being put out by the Vatudrip Company, 237 Broadway, New York. This has the advantage of drying on the surface so as not to be disagreeable to handle in a show room, while it is easily removed by a little oily waste, or can be wiped off with a plain piece of cloth. Samples of steel, with a portion protected and the rest badly rusted, seem to indicate that it makes good all the claims made for it.

In the presidential address before the American Chemical Society on the function of chemistry in conservation work it was pointed out that some oils are used practically crude for lubrication or burning. As a fuel for vessels, petroleum has many advantages, and the British Navy has been conducting tests with a view to using it on many of their ships. Most petroleums, however, are subjected to careful rectification and chemical purification. At one time the waste in the oil business was enormous, as only the kerosene was saved. Now, with the exception of occasional fires and the relatively small amount sprayed into the air with escaping natural gas, and the seepage from earth-pits used for storage of petroleum in certain sections of the country, the loss is very much less, for chemistry has not only shown how a greater yield of kerosene may be obtained, but also how all the by-products—gas, gasolene, naphtha, lubricating oils, paraffin, vaseline and coke—may be saved with considerable financial profit.

Trade Opportunities in Colombia

By M. de Moreira

Colombia is doing its utmost to interest American manufacturers and desires them to either invest their capital in various enterprises or to furnish the machinery needed for daily growing industries. While the destruction by locusts of the cotton crop has somewhat crippled the country, nevertheless other industries have been started. Railways are being built and Colombia is making the most of its opportunities.

The figures for the imports into Colombia for 1908 were $15,670,503—an increase of nearly three millions of dollars over the preceding year. The government has reported a gold surplus and every indication points to a betterment of financial conditions.

Railway Construction

At no time in her history has Colombia given more attention to the extension and improvement of its means of communication than at the present time. The government realizes that in this way only, can the vast mineral wealth and other natural resources of the country be developed. Lately the Girardot railway joined the Sabana railway, thus connecting the city of Bogota with Girardot on the Magdalena river and with the coast. Another line of considerable importance is the Pacific Railway which will connect Buenaventura, a port on the Pacific, with the fertile valley of Cauca. Work on the railway on the lower Magdalena river is also in progress and another railway is to be constructed, which will afford communication between Puerto Wilches on the Magdalena and the city of Bucaramanga. The Dorada, and the Zipaquira railways are also under construction at the present time.

Another important project is the proposed construction of a railway to connect the Cartagena railway with the Carribean coast, passing through Sincerin, where a new sugar refinery is being erected. This road will open to transportation the richest agricultural territory of Colombia and will be a powerful adjunct in the development of coalfields, petroleum wells and timber concessions. This proposed railway will naturally become a branch of the transcontinental system leading from Santa Maria on the northeast to Colon at the mouth of the Panama canal.

Street Railways

Street railways are also going through the improvement process. An extension of the street railway at Baranquilla has been granted by the government and American manufacturers will have an opportunity to prove that the underground system is better than the overhead trolley suggested by the Germans.

It seems that the opportunities for improved machinery for the construction of these various roads, as well as machine tools for the numerous repair shops needed, would suggest to our manufacturers the advisability of sending a representative and making a serious effort to obtain the orders which are practically waiting for them.

Water Transportation

Water transportation is also being seriously considered. The government has decided to dredge and reopen to traffic the canal leading from the Magdalena river to the bay of Cartagena and thus reëstablish direct-steamboat connection between this port and ports on the Magdalena. The original work on this canal was done in 1726, but by 1734 the canal had become partially filled up again. From 1844 to 1848 an American engineer was hard at work reëxcavating the canal which was kept free from obstructions until 1893 when it became impracticalble for navigation. The government has now decided to not only clear the canal of all obstructions but also to straighten it, as its tortuous course caused steamers much delay. Besides this improvement the Colombians have begun to realize the necessity of having more steamers on the river. The old Compañia Antioquena has decided to resume business and is placing orders for stern-wheel vessels of three hundred tons. The same company has bought a large water-front tract and will build there its docks, etc. Dredges, cranes, machine tools for repair shops, etc., will certainly be needed. Will England have, as in former years, the benefit of these purchases or will American manufacturers risk the competition they seem so much afraid of?

Mining

Besides being well supplied with gold, silver, emeralds, etc., Colombia possesses also iron, copper, lead and various other minerals, although gold is the principal mineral wealth of the country. It is interesting to note that the production of precious metals in that country dates from the Spanish conquest in the fifteenth century and that a few years ago the total production was estimated at $688,000,000. This production would have been greater, no doubt, had modern machinery been used. Even now the exploitation of these mines is done by very ancient and primitive processes.

Of all the mining territory in Colombia, the department of Antioquia is by far the richest. The mountain ranges are crossed with innumerable veins of gold-bearing quartz and the river valleys are rich in gold-bearing gravels. In most of the streams gold is found and it is hard to find a rivulet where gold cannot be seen. More than six hundred mines are at work in that province, of which thirty are owned by foreign companies, mostly English. If the natives could see the modern machinery used in mining and if manufacturers would not look for immediate profit but would be willing to let their salesman take their time in practical demonstrations, they would certainly reap a great reward which would more than repay for the time spent in obtaining it.

Manufacturing

Oil fields in Cartagena are another source of wealth for the natives but one which also needs modern machinery. The tracts of oil-bearing lands near Cartagena cover 12,000 acres and the manufacturer of well-drilling machinery and appliances used in refining petroleum will undoubtedly find great opportunities there.

Besides these natural advantages Colombia is every day undertaking new industries. Flour, for instance, which up to a short time ago was entirely imported, is now milled in the country and American machinery has shown its superiority over all other kinds to the extent that hardly any machinery from other countries is seen in these mills.

Shoes, which were previously made by hand or imported from France, are now manufactured in an uptodate plant with American machinery, and another factory is being built as the first one cannot supply the demand. The output of this new factory is to be four hundred pairs daily. Manufacturers of welt and turn machines, stitchers, sluggers, bottoming machines, etc., will have no difficulty, I am sure, in having their machines accepted.

Machinery is Duty Free

In addition to all these great opportunities there is still one more which ought to be appreciated by American manufacturers and which proves the desire which the government of Colombia has in favoring anything that tends to further the progress and development of the country. This opportunity is the freedom from duty of all machines which will serve in the development of industries in Colombia, providing the machine weighs at least three thousand pounds gross—the government considering the boxing and packing part of the machinery and including it in the gross weight. This will assist American manufacturers to deal with advantage to themselves and at the same time facilitate the introduction of their machines.

One word of caution is needed regarding the packing. Our manufacturers must bear in mind that transportation in Colombia is not very easy and since they are ignorant of even the means of interior communication they should obey implicit-

ly the requests and instructions of the purchasers. In doing so, they will not only avoid refusal of acceptance of their machines but also overcome the reputation they have unfortunately acquired of packing goods for long and hard travel in the interior of foreign countries in the same manner as for short shipments in their own where railroad accommodations are of the best and where one gage is universal.

Combination Caliper Gage

By Wm. G. Zinsmeister

The sketches show a caliper gage made up of but few members, but which may be used for thousands of different measurements, both external and internal. This gage is patented by Bernard J. Roehm, of Cincinnati, Ohio. It consists of a rectangular body or holder, in which are clamped a series of parallels or jaws of different widths, and a micrometer attachment adapted to be held in the same way as the plain jaws. The latter, as will be seen, are rounded at one end for internal gaging, the other end being left square. Various ways of combining the gage jaws for different measurements will suggest themselves and a number of practical applications are presented in Figs. 5 to 8. The gage in these sketches is but 4 inches long and 2½ inches wide. It is extended to 6 inches for internal measurements by applying the micrometer head as indicated. Of course, the device may be made of any desired size, each additional parallel giving many new combinations. It will be noticed that when the jaws are slid through the holder for any given standard size the intermediate parallel forms the standard internal gage of the same size. Thus in Fig. 5 the one-inch parallel is slid forward for gaging the bore of a gear, while the rear ends of the jaws at either side form an external snap gage for testing the shaft for the gear. By using the micrometer head in the manner illustrated, the end of the shaft may be left larger than standard for a driving fit, or smaller for a free fit.

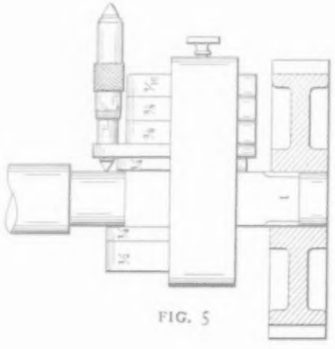


FIG. 5

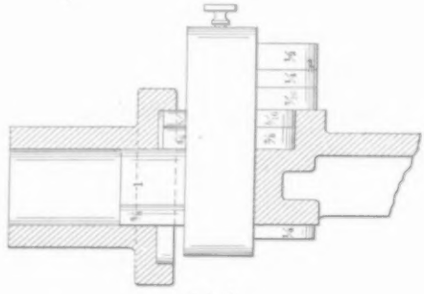


FIG. 6

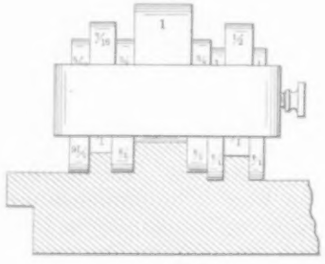


FIG. 7

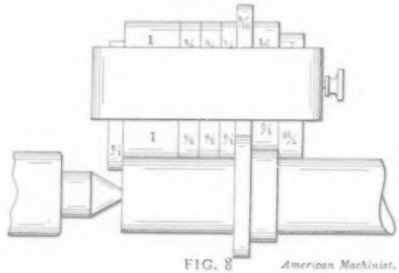


FIG. 8

American Machinist, N.Y.

APPLICATION OF COMBINATION CALIPER GAGE

FIG. 1

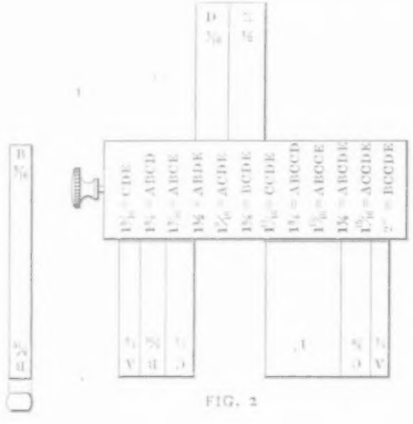


FIG. 2

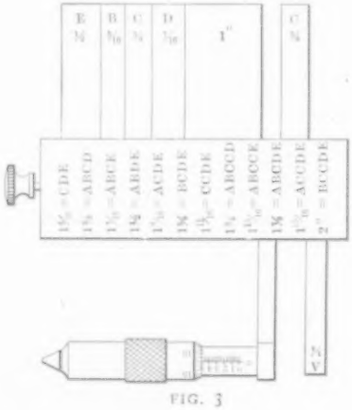


FIG. 3

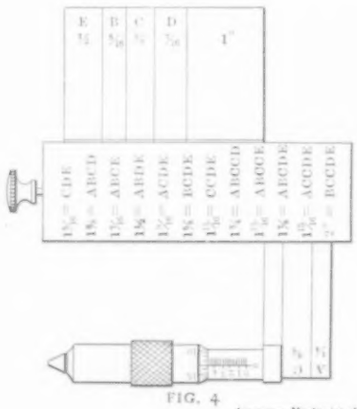


FIG. 4

American Machinist, N.Y.

COMBINATION CALIPER GAGE

Fig. 6 shows a casting that has been bored and turned out under the flange and the method of applying the gage will be obvious. The opposite end of the gage is represented as applied to a piece machined on the shaper or miller. Machine parts having standard thicknesses, bearings, tongues, grooves, etc., are readily gaged with this tool. Tongues and grooves may be easily matched; as in Fig. 7 one end can be set for gaging the groove and the opposite end is then right for the tongue. Another application which is self-explanatory is shown in Fig. 8.

According to Dr. David T. Day, of the U. S. Geological Survey, the total production of petroleum in the United States in 1907 was approximately one hundred and sixty-six million barrels, valued at $120,000,000, or forty million barrels more than in 1906, this increase being greater than for any year previous to 1889.

The Right to Be

Someone once said that "many men are valuable not for what they do, but for what they are." While this is unquestionably true, an analysis will usually, if not always, show that those whose value is measured by what they are have demonstrated that they became what they are by their ability to do. What they did and the way it was done proved their titles to be classed with those who are instead of with those who only do.

In the middle of a very busy time the gasket under a 4-inch pipe flange blew out. The fire was drawn, the boiler allowed to cool, and a new gasket put in. A new fire was built, and as the steam pressure crawled upward toward the working point, the men began to get ready for work; but just as the engineer was about to open the throttle, with a sharp hiss followed by a bang, the new gasket let go. With maledictions both blunt and pointed on the part of those who had participated in the work of putting in the gasket which failed, the fire was drawn and the entire performance repeated, and with the same final result, and then once more.

Discouraged and disheartened, weary and supperless, the engineer confessed his defeat and suggested that perhaps some other engineer might have better luck, if called upon for consultation or advice. At the central station there was a man who had never had any bad luck with gaskets, hot boxes or broken follower bolts, and who had the reputation of being a good engineer. He it was who was sought, routed out of bed, and got to the plant. Here he was asked to take charge of the job of putting in a new gasket and one that would stay.

After hearing the story, the man from the central station made an examination. He found the surface of the flange and the boiler head in good shape, and the gasket material of good quality. Then the studs in the boiler head which passed upward through the flange on the end of the pipe were examined. On one of the studs the threads were bright and slightly deformed as though a nut which did not fit had been used. Such proved to be the case. One of the nuts would not screw easily onto any of the studs, while all of the other nuts would run on all of the studs except the one that appeared damaged. Here was the seat of the trouble. The nut on the damaged stud went hard, and the power put on the wrench was expended in overcoming friction instead of producing pressure on the flange, and this lack of pressure allowed the gasket to fail.

A split screw-cutting die of the proper pitch and a new nut were found, and with the die held in a patternmaker's clamp, it was run up and down on the stud until any and all of the nuts could be screwed up and down with the fingers. With a new gasket the parts were assembled, and as steam was raised the joint was "followed up" by one of the helpers. Steam was raised and the joint held; pressure was increased until the blowing of the safety valve told that the limit of pressure had been reached, but the joint held, and it is certain that two years afterward it was still holding.

The man from the central station was its chief engineer, and was one of those who are paid for being rather than for doing, for at the station he seldom or never did anything; packing, joint making, keying and indicating being attended to by subordinates.

But the fundamental difference between the two men lay in something deeper than the manual skill necessary to cut gaskets or turn nuts on flange bolts. There was a failure where failure was not expected. One simply repeated the process that made failure possible, the other sought and found the cause of failure before taking even the first step in the making of the joint. It was a simple matter but, like all other problems that come to the man who operates a steam plant, it required the exercise of plain common sense. There was an effect that must have had a cause; the cause found and removed, the effect disappeared. The man who sought, found and removed the cause did nothing wonderful, but he showed that he could do and by his ability to do proved his right to be.—*Power and the Engineer.*

The Problem of a Vacuum Bottle

By C. M. Ripley

How many of us read the advertisements, "Keeps Liquids Hot for One Day and Cold for Three Days" that are appearing in the street cars and in our magazines? How many of us ever stop to think what law governs this difference? I recently called at the sales office of one of these vacuum-bottle companies, and think that the conversation that follows should be made part of contemporaneous "engineering" literature.

Inquisitive Caller: Why is it your bottle doesn't keep liquids hot as long as it will keep them cold?

Vacuum "Expert:" Why that's easy. Heat travels faster than cold.

Inq. Caller: You mean the heat will travel *outwardly* from the bottle more rapidly than the cold will travel *outwardly?*

Vac. Expert: Exactly sir. Exactly.

Inq. Caller: But cold is simply the absence of heat. It seems to me that they would both travel at the same speed.

Vac. Expert: Oh no. Heat waves are always more rapid than cold waves.

Inq. Caller: Now let's see if I understand you. Say we have a bottle of your vacuum type, filled with ice water. You say that this will stay cold for three days. In order for it to get warm, the heat from the air must travel *inwardly* to the ice water. This you say takes three days.

Vac. Expert: Yes that's right.

Inq. Caller: Now if we had hot liquid in one of your bottles, the cold must travel inwardly in order to cool it off. This you say takes one day. Is that right?

Vac. Expert: That's the idea, old man.

Inq. Caller: Well then, if the *cold* can do in *one* day what it takes *three* days for the *heat* to do, it seems to me that cold must travel three times as fast as heat, although you say that heat travels faster than cold.

Vac. Expert: Well, er, that is, you see, heat travels *out* faster than it travels *in*, but cold travels *in* faster than it travels *out*.

Inq. Caller: Ummmmm. That's queer, isn't it? And yet it seems to me that as the heat travels *out* the cold must travel *in* at exactly the same speed, just as when the sun rises, the dark travels away just as fast as the light travels toward us. I always thought that heat and cold were to each other exactly what light and darkness are to each other.

Vac. Expert: Well, my friend, I'm sorry I can't make you see this. But it's a fact just the same that heat will travel faster than cold.

Inq. Caller: Which way, inwardly or outwardly?

Vac. Expert: (with a bored expression): Why anyway, either way. That is a fixed law among the scientists.

Inq. Caller: But if the cold will get into the bottle in one day, and it takes three days for the heat to get in, I can't quite understand.

Vac. Expert (very much annoyed): That was just a slip of the tongue; cold does travel faster than heat. That's one on me.

Inq. Caller: But the heat will travel *out* of the bottle in one day and it takes three days for the cold to travel out of the bottle. So when you think about it that way it seems that after all the heat travels faster than the cold.

Vac. Expert (very much annoyed): Well you see it depends. Now, really, I've only been in this business for four days, and I'll call in our shop superintendent who is really the father of the vacuum bottle. (Presses a button. Mr. Buzz enters.) Now Mr. Buzz will you please explain to his gentleman the real scientific reason for the fact that our wonderful bottle will keep a liquid cold three times as long as it will keep it hot?

Mr. Buzz: Abh! Um! I should be glad to, sir. You see in 1873 when I first brought out this wonderful invention, I was confronted with a very difficult problem in thermodynamics. That minute margin of sealed contact between the in-

ner bottle and the outer bottle, besides the tiny platinum contact to the bottom, the radiation from which is practically negligible, coupled with the peculiar effect which light brings to bear upon the question of heat radiation, led me to a most exhaustive study of molecular action and a practical application of Dewar's flask. You see, my dear sir,— —

Inq. Caller (interrupting): But why does it stay cold longer than it stays hot? I want to know *why*, if you can tell me.

Mr. Buzz: Well, in the first place, we will start with the fixed and fundamental law that heat travels faster than cold—

Inq. Caller: Gentlemen, thank you. Good afternoon.

CHAPTER 2

In my room that evening, I got out my pencil and paper and figured what the normal temperature would be, and how far from the normal a hot liquid would be in winter as compared with a cold liquid in summer. In using the Fahrenheit scale, I could see no reason for the great variation in the length of time. In using the Centigrade scale, I came nearer being able to explain the phenomenon. But I am still almost as unsatisfied with any attempts as I was with the elaborate and involved explanations of the patient, "vacuum expert" and the bombastic Mr. Buzz.

It might be a good advertising scheme for some vacuum-bottle manufacturer to offer a prize bottle to each competitor in a "guessing contest." I am hoping some of the readers of this paper will be able to enlighten me better than either the "father of the vacuum bottle" or his four-day-old "vacuum expert," as he first termed himself.

The First American to Buy an Aeroplane

On Tuesday night, June 22, C. F. Wyckoff, of Wyckoff, Church & Partridge, New York, Eastern distributors for Stearns automobiles, quietly and unostentatiously arranged with the noted aviator, A. M. Herring, for the selling of aëroplanes made by the Herring-Curtiss Company.

Within 24 hours C. William Wurster, who takes care of the publicity and advertising for Wyckoff, Church & Partridge, sold the first practical aëroplane ever purchased in this country by a private individual to A. P. Warner, vice-president and general manager of the Warner Instrument Company, of Beloit, Wis.

Mr. Warner happened to be in New York City, and after a three minutes' talk with Mr. Wurster, contracted to take the first of the Herring-Curtiss aëroplanes to be sold by the New York automobile firm.

For a number of years Mr. Warner has made a close study of aviation in all its forms, and has kept himself fully posted on the progress of the various American and foreign heavier-than-air machines. He has been for some time peculiarly interested in the careful experiments which have been conducted by A. M. Herring and Glenn S. Curtiss, and has come in close personal contact with the former during the past six months.

Mr. Warner now enjoys the unique distinction of being the first private gentleman to own an aëroplane which an amateur can readily handle in the air for an hour or more.

The contract provides for delivery of the aëroplane within 50 days, and the assembling of the various parts will be begun at once.

It is the intention of Mr. Warner to accept delivery of his machine in New York where the demonstration trials will probably be held, after which he proposes to take it to Indianapolis, for the purpose of entering it in the various aëronautic events to be held in September at the motordrome. He further proposes to operate the aëroplane himself, as it has been his desire for some time to try this sensation of air mastery just as soon as a practical machine could be had.

The problem of an improved instrument which will register the speed of an aëroplane while in flight is just now of the greatest interest to Mr. Warner, and he proposes to begin experiments along this line just as soon as he has mastered the handling of the machine just purchased.

A. Bradshaw Holmes

A Bradshaw Holmes, secretary and treasurer of the Independent Pneumatic Tool Company and Aurora Automatic Machinery Company, Chicago, Ill., died on June 30, 1909, from injuries sustained by accidentally falling from the piazza of his hotel. He was 31 years of age.

Mr. Holmes was well known in the pneumatic tool business, having been connected with the Standard Pneumatic Tool Company and the Rand Drill Company for a number of years prior to his connection with the Independent Pneumatic Tool Company, of which corporation he was secretary and treasurer since its organization.

Business Items

The works of the Brown & Sharpe Manufacturing Company, Providence, will be closed from August 6 to 23 for the annual vacation and repairs. During the vacation the offices will be open as usual and all orders will receive the usual attention.

Business Opportunities

J. M. Dodd, Buchanan, Va., will establish a foundry.

The Texas & Pacific Railway will erect a new roundhouse at Burham, Texas.

The Joliet (Ill.) Railway Supply Company will double the size of its factory.

The Buffalo (N. Y.) Pen Company, a new concern, will erect a two-story factory.

The Warner Fence Company, of Ottawa, Kan., will build a plant in Pueblo, Col.

Wm. F. Taubel Company, Riverside, N. J., will build an addition to its hosiery mill.

The Acme Manufacturing Company, Tacoma, Wash., will erect a boiler house and dry kiln.

The Columbus (Ohio) Dental Manufacturing Company will build a new $12,000 factory.

An addition will be built to the factory of James Smith & Son, machinists, Worcester, Mass.

The Sheldon Axle Company, Wilkes-Barre, Penn., is building an addition to its spring plant.

Plans have been drawn for a new plant for the Southern Indiana Stove Works, Evansville, Ind.

The Dempster Mill Company, Beatrice, Neb., has begun the erection of a new implement factory.

The Universal Stone Crusher Company, Clinton, Iowa, has had plans prepared for a new factory.

The plant of the Cambria Forge Company, Johnstown, Penn., was burned. Loss, about $50,000.

The Milwaukee (Wis.) Aluminum Manufacturing Comyany will build a two-story brass foundry.

The Stirling Manufacturing Company, Littleton, N. C., will erect an addition to manufacture doors, etc.

F. F. Martenn, of Boaz, Ala., will establish a machine shop, foundry and blacksmith shop at Oneonta, Ala.

The Standard School Desk Manufacturing Company, Columbus, Ga., will establish a foundry and machine shop.

Kitselman Bros., Muncie, Ind., fence manufacturers, are erecting an addition to be used as a machine shop.

The American Chair Company, of Seymour, Ind., will move to Muncie, Ind., where a new plant will be erected.

The Aeolian Company, Meriden, Conn., manufacturing musical instruments, will erect a new five-story factory.

It is announced that the Union Pacific Railroad will establish a steel works and rolling mills in Greeley, Colo.

The Enterprise Brass Foundry Company, Tacoma, Wash., has taken out a permit for new foundry building.

The Farr & Bailey Manufacturing Company, Camden, N. J., oilcloth manufacturers, will erect an addition to their plant.

The Chattanooga (Tenn.) Sewer Pipe and Fire Brick Company will erect a one-story machine shop at its plant.

The Vanguard Manufacturing Company, Joliet, Ill., manufacturing automobile accessories, has bought site for a new plant.

The Logan Carriage Company, Parkersburg, W. Va., is said to be contemplating installing an automobile department.

The New York Central Railroad Company will soon begin the erection of a machine and blacksmith shop at West Albany.

Fire destroyed the canning plant of the California Fruit Canners' Association at Milpitas, Cal., causing a loss of nearly $200,000.

Plans are about completed for the plant of

the Albany (Ga.) Cotton Mills, a recently organized concern. W. W. Pace is president.

The repair shop and roundhouse of the Tonopah & Goldfield Railroad, Tonopah, Nev., were burned, causing a loss of about $100,000.

The Alan Wood Iron and Steel Company, Conshohocken, Penn., contemplates the erection of a new plate mill to cost about $150,000.

The Saratoga Graphite Company, organized a short time ago, has begun the erection of a separating and refining mill at Wilton, N. Y.

The Palmer-Singer Company, of New York, has filed plans for a large automobile factory and garage to be erected in Long Island City.

The Hoopes & Townsend Company, Philadelphia, Pa., manufacturing bolts, etc., contemplates the erection of a ten or twelve-story building as an addition to its present plant.

Hugh Warner, Muncie, Ind., is building a new factory for the manufacture of automobile sundries, which will include the present small factory, now operated by Mr. Warner. The company will be known as the Muncie Gear Company.

The Johnson Automatic Switch Company, Spokane, Wash., is preparing to erect a plant to manufacture automatic switches invented by R. E. Johnson, who is president of the company. The company is capitalized at $100,000.

The American District Steam Company, of Lockport, N. Y., will shortly award contracts for a two-story machine shop to be erected at the plant recently built at North Tonawanda, on completion of which the entire plant will be moved there.

The move to erect a large steel manufacturing plant at South Buffalo, N. Y., is being made by B. L. Worden, president of the Worden-Allen Company, Milwaukee, Wis., and other Milwaukee capitalists. The plant is to be completed by September 1, and will be one of four similar plants to be the largest of their kind in the country. The Buffalo plant will have an annual capacity of 40,000 tons of finished steel material. The new concern is to be known as the Lackawanna Bridge Company.

New Incorporations

The Burnt Knoll Brick and Coal Company, Boulder, Colo., has been incorporated to manufacture pressed and fire bricks. Capital, $100,000 C. F. Reynolds, president.

The Lubertzy Brake Works, Portland, Me., has been incorporated to manufacture engines and motors. Capital, $5,000.00. Incorporators, A. H. Pearey, G. E. Burnham, of Kittery, Me.

The Cleveland Chuck Company, Cleveland, O., has been formed to place on the market an automatic two-jaw chuck. F. J. Ellsworth, of the Adjustable Collet Company, is president.

The Louisville Brazing and Machine Company, Pittsburg, Penn., has been incorporated with $15,000 capital. Incorporators, F. C. Tygard, G. R. Tygard, J. W. Tygard, of Pittsburg.

The Garden City Machinery Company, Chicago, Ill., has been incorporated to manufacture machinery. Capital, $50,000. Incorporators, R. H. Stoll, C. H. Bryce, W. D. Scrugham.

The Slade Tubing Company, Rome, N. Y., has been incorporated to manufacture brass and copper tubing. Capital, $50,000. Incorporators, B. Haselton, J. A. Spargo, F. M. Shelby.

The Eccentric Wrench Company, Marion, Ind., has been incorporated to manufacture nut and pipe wrenches. Capital, $35,000. Incorporators, A. Middleton, E. E. Sheckley, W. H. McGraw.

The Bayonne Casting Company, Bayonne, N. J., has incorporated as machinists, founders, etc. Capital, $100,000. Incorporators, Wm. J. Edwards, Leroy Edwards, Bayonne; John More, Stapleton, S. I.

The Automatic Meter Guard Company, Chicago, Ill., has been incorporated with $100,000 capital. Incorporators, F. Hintze, W. F. Frendenreich, W. H. Chamberlin. They will manufacture water meters.

The Chicago Pump Company, Chicago, Ill., has been incorporated to manufacture and deal in machinery, appliances, etc. Capital, $10,000. Incorporators, George N. Killelea, A. H. Wilson, Henry Horner.

The General Calculator Company, Chicago, Ill., has been incorporated to manufacture machinery, office devices and appliances. Capital, $60,000. Incorporators, Herman Jonas, Richard Fischer, M. M. Grossman.

The Improved Railroad Switch Company, Woodbury, N. J., has been incorporated to manufacture railroad switches, wagons and wagon supplies. Capital, $250,000. Incorporators, D. B. Broadwater, A. M. Downs, Clayton; C. T. White, Millville.

New Catalogs

Crescent Tool Company, Jamestown, N. Y. Catalog of wrenches, pliers, etc. Illustrated, 20 pages, 3½x6 inches, paper.

Modern Tool Company, Erie, Penn. Pamphlets illustrating and describing Universal grinder No. 2 and plain grinder No. 12.

Joyce Cridland Company, Dayton, Ohio. Bulletin No. 35, describing lever jacks. Illustrated, 24 pages, 4x9 inches, paper.

The Veeder Manufacturing Company, Hartford, Conn. Catalog No. 15, describing Veeder die castings. Illustrated, 3½x6 inches, paper.

The Whitman & Barnes Manufacturing Company, Chicago, Ill. Catalog No. 72, describing Diamond high-speed twist drills and reamers, Norka and Hercules high-speed twist drills, Economy high-speed flat drills and track bits, drill chucks, sockets, sleeves, etc. Illustrated, 78 pages, 6x9 inches, paper.

Want Advertisements

Rate 25 cents per line for each insertion. About six words make a line. No advertisements abbreviated. Copy should be sent to reach us not later than Friday for ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded, they will be destroyed without notice. No information given by us regarding any advertiser using box number. Original letters of recommendation or other papers of value should not be inclosed to unknown correspondents. Only bona-fide advertisements inserted under this heading. No advertising accepted from any agency, association or individual charging a fee for "registration," or a commission on wages of successful applicants for situations.

Miscellaneous Wants

Caliper list free. E. G. Smith, Columbia, Pa

We buy and pay royalty for good patented machine or tool. Box 282, AMER. MACH.

Hand power bending tools, labor-saving, money-making. Estep & Dolan, Sandwich, Ill.

Light, fine machinery to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

A large foundry and machine shop desires to add to present lines of manufacture. Box 126, AMERICAN MACHINIST.

Machines designed; automatic special. Practical working drawings. C. W. Pitman, 3519 Frankford Ave., Philadelphia, Pa.

Special machinery accurately built. Screw machine or turret lathe work solicited. Robert J. Emory & Co., Newark, N. J.

Light and medium weight machinery and duplicate parts built to order; tools, jigs, etc. MacCordy Mfg. Co., Amsterdam, N. Y.

We design and build all kinds of light machinery, including dies, fixtures, tools and model work. The Matson Machine Co., Bethel, Vermont.

Wanted—Designs and prices of machines for tapping iron pipe fittings two to six inch. Box 126, AMERICAN MACHINIST.

Metal specialties manufactured; models, dies and special machinery. Inventions perfected; correspondence solicited. W. E. Villinger, Williamsport, Pa.

Wanted—To sell or negotiate machine patents, etc.; highest possible endorsements; $10,000 to $25,000 backing required. "Builder," 808 N. C. Ave., Washington, D. C.

I have an unusually good proposition. Wish to connect with firm desiring additional line of manufacture. Would consider organization of new company. Box 387, AM. MA.

Purchaser for No. 2 Farwell milling machine, Grant hobbing machine and Gisholt tool grinder; all practically new and in A-1 condition. Box 408, AMERICAN MACHINIST.

A large English firm of machine-tool importers having showrooms and offices in Great Britain, France, Italy and Japan, is wanting good agencies for machine tools of all kinds. Apply Box 189, AMERICAN MACHINIST.

To machine tool builders: I have an automatic screw machine (multiple spindle) which has a world wide demand; each spindle independent and can do four different kinds of work consecutively without change. It is universal, requiring no change of cams, or other parts of machine for any different kinds of work, all changes required being done by set screws and can be accomplished in a few minutes without one cent cost. It is the simplest, strongest, handsomest machine on the market. I will give contract for term of years or royalty. Box 413, AMER. MACH.

Wanted—One steam-driven air compressor, 12x12x12 to 14x16x14, can use a belted machine; one splitting shear, capacity ½" plate; one bevel shear, capacity ¾ to ¼" plate; one 32" to 48" back-geared drill press; one bulldozer to correspond in size to Williams & White No. 5 or 6; one angle bender to bend 4x4x½" angles; one rotary structural planer, one large size friction saw. These machines must all be practically as good as new and of standard manufacture of modern type. Address, stating details, also price and point of shipment, to Box 393, care AMERICAN MACHINIST.

Situations Wanted

Classification indicates present address of advertiser, nothing else.

CONNECTICUT

Practical mechanic; broad experience as general foreman, on general jobbing and construction work, good executive ability; best of references; will go any where, middle west preferred. Box 400, AMERICAN MACHINIST.

Superintendent, assistant or general foreman, age 35, practical man with executive ability, experienced in handling skilled mechanics, up-to-date and original in designing and building dies, jigs and labor-saving devices economically for rapid and accurate manufacturing of small or medium work sewing machines, adding machines and similar appliances. Salary $2500. Box 395, AMERICAN MACHINIST.

FOREIGN

Selfstarting Motors (Patented)—Practical young man desires to join first class electrical firm (alternating or three-phase current) for the purpose of introducing new promising device in connection with self-starting motors. Offers should be addressed "K. G. U." 258 F. Rudolf Mosse, Cologne, Germany.

ILLINOIS

Designer with experience on sheet metal working machinery dies and tools. Box 406, AMERICAN MACHINIST.

Position as assistant superintendent or master mechanic in manufacturing concern; good technical education with 12 years' shop and drawing office experience; at present employed. Box 399, AMERICAN MACHINIST.

INDIANA

A natural born mechanic and foreman, A-1 machinist and diemaker, expert on punch presses, successful organizer, also in handling men, at present holding a responsible position with good recommend, open for engagement in two weeks; good foreman position will be accepted; married man, age 29. Address M. N., P. O. Box 61, S. Whitley, Ind.

MASSACHUSETTS

Foreman, 18 years experience, gasolene, steam engines and automobiles; can design tools, jigs and fixtures for rapid interchangeable work. Box 410, AMERICAN MACHINIST.

MICHIGAN

Mechanical engineer wants position on executive force with some car building, gas or steam engine building or structural steel plant; technical graduate; eleven years' practical experience; age 33; middle or far west preferred. Box 384, AMERICAN MACHINIST.

NEW JERSEY

Mechanical engineer, graduate, with sev-

eral years' experience in general machinery, gas engines, automobiles and pumping machinery, desires responsible position. Age 28. Box 390, AMERICAN MACHINIST.

Man with 20 years' experience as superintendent and manager of large machine works is open for an engagement August 1. Applicant is fully qualified to assume entire charge of office and works as its official head. Have good executive ability, good organizer and can produce maximum amount of work at minimum cost. Box 371, AMER. MACHINIST.

NEW YORK

Mechanical designer and superintendent, eight years' experience automatic and general machinery, wishes responsible position. Box 404, AMERICAN MACHINIST.

Foreman for machine shop employing about 50 men; state age, experience, salary and give references, which will be considered confidential. Box 405, AMERICAN MACHINIST.

Salesman, tools, machines, supplies; expert mechanic, can demonstrate, operate and do whatever is requested; best of references. Investigate. Box 402, AMERICAN MACHINIST.

Assistant superintendent and foreman is open for position: tool and die work; expert machinist; executive; age 34; high-grade references. Interview. Box 403, AM. MACH.

Wanted—Position assistant to chief engineer or superintendent, technical graduate, thoroughly experienced in designing and manufacturing high grade machinery and tools. Box 396, AMERICAN MACHINIST.

Wanted—Position as factory manager or superintendent. Wide experience manufacturing guns, typewriters, cash registers, sewing machines, phonographs and adding machines, also small and heavy electrical apparatus. Thoroughly conversant with modern tool design and piece work systems. Expert mechanical and executive ability. I am at present superintendent of factory employing four hundred hands, but for good reasons desire a change. Box 392, AMERICAN MACHINIST.

PENNSYLVANIA

Chief draftsman of factory desires a change; 30 years old; ten years in drafting departments; experience in tool design for rapid and interchangeable manufacturing, adding machines, talking machines, etc. Box 398, AMERICAN MACHINIST.

Technical, mechanical and electrical engineer graduate desires position; practical experience in machine and erecting shop, including foreman, drafting room (designing), engineer of tests, superintendent of erection and engineer for firm. Box 407, AM. MACH.

Help Wanted

Classification indicates present address of advertiser, nothing else.

CANADA

Wanted—First-class toolmakers and machinists, accustomed to automobile, jig and fixture work. Apply Reo Motor Car Co. of Canada, Ltd., St. Catharines, Ont.

Mechanical engineer wanted for charge of designing and drafting office of large engineering works; give experience. Address, Canada Foundry Company, Ltd., 212 King St., West, Toronto, Canada.

Wanted—Cream separator manufacturing company wants experienced and energetic foreman to take charge of machine shop; salary $100 per month; position permanent to the right man. Applicants will state age, experience and give references. Box 373, AMERICAN MACHINIST.

ILLINOIS

Wanted—First-class vise and floor hands; only those accustomed to machine tool work need apply. Write the Ingersoll Milling Machine Co., Rockford, Ill.

Wanted—A-1 machine designer, with experience on special and automatic machinery; state age, experience and salary expected. Address Box 411, AMERICAN MACHINIST.

A machinery manufacturer, prominent in his line, desires to get in touch with a man thoroughly versed in modern turret lathe practice—one who can take charge of a battery of Gisholts and produce the results of which machines are capable. Must have experience fitting him to tool the machines properly for numerous different classes of work such as we have. We wish to hear only from progressive men of A-1 habits who desire to better themselves and are willing to pitch in hard in their own interests as well as ours. Address stating fully your qualifications, Box 391, AM. MA.

INDIANA

Two experienced foremen for machine and assembling rooms, manufacturing gasolene motors. Give reference, experience and age. Box 262, AMERICAN MACHINIST.

Wanted—A man as foreman of hardening department. One who has had experience in hardening fine punches and dies and case hardening small parts of carbon and nickel steel. State age, experience and give reference. Box 369, AMERICAN MACHINIST.

MARYLAND

Wanted—Three or four first-class draftsmen on heavy general machinery, structural and general arrangement work. Address Ellicott Machine Company, Baltimore, Md.

MASSACHUSETTS

Wanted—Experienced time study man, one with mechanical training preferred. This is a steady job with good chances for the right man. Apply to Post Office Box 5285, Boston, Mass.

MICHIGAN

Wanted—A few first-class toolmakers on small work; good wages and steady employment for competent men. Box 278, AM. MA.

MISSOURI

Wanted—Superintendent, an American, 30 to 45 years of age; good mechanic, good executive, systematic, progressive and aggressive; up on duplicating manufacturing, with not less than three years' experience as superintendent of a gas engine factory; must have earned at least $1800 per annum and saved something; to such a person we offer superintendency of our modern gas engine works, backed by all of the money, tools, appliances and material necessary to turn out 3000 engines per year at least possible expense; time is an important consideration; give full and complete history and be prepared to pay us a visit, if apparently satisfactory. Witte Iron Works, Kansas City, Mo.

NEW JERSEY

Wanted—A tool draftsman on small, fine intricate work, for large shop in New Jersey. Only men of experience on the above line of work need apply. In answering state experience and wages expected. Address Box 378, AMERICAN MACHINIST.

NEW YORK

Wanted—Several first-class machinists; turret lathe, boring mill and lathe. Kerr Turbine Co., Wellsville, N. Y.

Wanted—Operator on Gisholt turret lathe. State experience and pay expected. Address Otis Elevator Company, Yonkers, N. Y.

Wanted—Man to take charge of the grinding department in an automobile factory. Must be a man who has held similar position and be able to produce results. Maxwell-Briscoe Motor Co., Superintendent's Office, Tarrytown, N. Y.

Wanted—High-class man over thirty years of age, for position as chief clerk in manufacturing plant. Must be familiar with cost systems, purchasing of iron and steel materials, and general office management; best references required. Box 401, AMER. MACH.

Wanted—An expert on hardening and tempering; one with broad experience and a master of the business; a steady all-year-around position is offered with best of conditions by an old established firm. Give experience in detail and wages expected. "P. R. S.," AMERICAN MACHINIST.

Wanted—By concern in vicinity of New York assistant in mechanical engineering department. Must have had technical education and practical experience in production and erection of elevators. Give age, experience, references and salary expected. Box 397, AMERICAN MACHINIST.

OHIO

Draftsman Wanted—A married man experienced in paper-mill machinery preferred; permanent position. Shartle Bros., Middletown, Ohio.

Good automobile and tool draftsmen wanted. No others need apply. Ask for Mr. Allen, Chief Draftsman, The Toledo Motor Co., Toledo, Ohio.

Wanted—Machinists, only good men need apply; crank lathe, planer, boring mills and bars, radial drills, Jones & Lamson screw machines, floor and vise hands. Increasing force, steady work, good wages. Box 412, AMERICAN MACHINIST.

PENNSYLVANIA

Machinists wanted. Lathe, boring mill and floor hands, air compressor work. The Blaisdell Machinery Co., Bradford, Pa.

Draftsman Wanted—A man familiar with air compressor work. State age, experience, salary. Box 394, AMERICAN MACHINIST.

Salesman Wanted—Man thoroughly experienced; A-1 in buying and selling machine tools, as used in machine shop equipment. A. J. Kensler, 491 N. Third St., Philadelphia.

Wanted—Draftsman, experienced in machine tool and jig work. Must also be a good general detailer. Man with shop experience or technical graduate preferred. Box 414, AMERICAN MACHINIST.

Mechanical engineer wanted by prominent gas engine builders; must be an expert in modern gas engine and producer practice, good organizer, familiar with up-to-date drafting room and shop methods. Box 415, AM. M.

Wanted—A good live agent in every shop or factory in the U. S. to sell one of the best known preparations for removing grease and grime from the hands without injury to the skin. Absolutely guaranteed. An agent can make from $5.00 to $25.00 over and above his regular salary. This is no fake. Write for free sample and agents' terms. The Klenzola Co., Erie, Pa.

VIRGINIA

Wanted—To teach drawing in a State School of Technology, a graduate in architecture from a German technical school; an excellent opportunity for a young man desiring to make teaching his profession; must be particularly competent in free-hand drawing. Box 377, AMERICAN MACHINIST.

WISCONSIN

Reliable machinists who desire steady employment in an automobile factory located in a cool, healthful, small city are advised to call, ready for work, at any time within four months, at the Rambler factory, Kenosha, Wis.

For Sale

For Sale—Automatic double headed wood cutting machine for shoe lasts, smoking pipes, etc; everything in wood that is made from a model. Will sell patent rights, working drawings, etc. Box 409, AMER. MACHINIST.

Alphabetical Index to Advertisers

	PAGE
Abrasive Material Co.	118
Acme Machinery Co.	131
Adams Co.	140
Albro-Clem Elevator Co.	108
Almond Mfg. Co., T. R.	110
American Emery Wheel Wks.	118
American File Sharpener Co.	124
American Gas Furnace Co.	121
American Pulley Co.	127
American School of Correspondence	117
American Tool and Mach. Co.	130
American Tool Works Co.	8
American Tube and Stamping Co.	143
American Wood Working Machinery Co.	109
Armstrong-Blum Mfg. Co.	116
Armstrong Bros. Tool Co.	144
Automatic Machine Co.	136
Baker Bros.	112
Barnes Co., Wallace	109
Barnes Co., W. F. & John	14
Barnett Co., G. & H.	50
Bath Grinder Co.	87
Baush Machine Tool Co.	24
Bay State Stamping Co.	109
Beaman & Smith Co.	15 and 110
Beaudry & Co., Inc.	17
Becker Milling Machine Co.	23
Bemis & Call Hardware and Tool Co.	132
Besly & Co., Chas. H.	135
Bethlehem Foundry and Machine Co.	124
Bignall & Keeler Mfg. Co.	108
Bilgram Machine Wks.	107
Billings & Spencer Co.	119
Birdsboro Steel Fdry. and Machine Co.	139
Blaisdell Machinery Co.	117
Blanchard Machine Co.	132
Bliss Co., E. W.	31
Blount Co., J. G.	118
Boker & Co., Hermann	85
Boston Gear Works	106
Boston Saw & Tool Co.	116
Bradford Machine Tool Co.	5
Bristol Co.	4th cover
Brown & Co., R. H.	110
Brown & Sharpe Mfg. Co.	94, 95 and 4th cover
Browning & Co., Victor R.	126
Brubaker & Bros., W. L.	116
Buffalo Fdry. & Machine Co.	117
Bullard Machine Tool Co.	49
Butterfield & Co.	99
Caldwell & Son Co., H. W.	127
Carborundum Co.	26
Card Mfg. Co., S. W.	25
Carpenter Tap & Die Co., J. M.	134
Carter & Hakes Machine Co.	112
Carver File Co.	109
Chadwick & Trefethen	116
Chambersburg Engineering Co.	153

The Making of Incandescent Electric Lamps

An Everyday Domestic Article, the Commercial Production of Which Is Much Cheapened by a Number of Ingenious Glass Manipulating Machines

EDITORIAL CORRESPONDENCE

Although most of us are more familiar with the incandescent electric lamp than the countryman who complained that he could not blow out his light in the city hotel because the blamed thing was in a bottle, it is not everybody who knows how these lamps are made under modern methods such as those used by the Westinghouse Lamp Company, at Bloomfield, N. J.

The making of the incandescent electric lamp involves an unusually large number of progressive steps and employs along

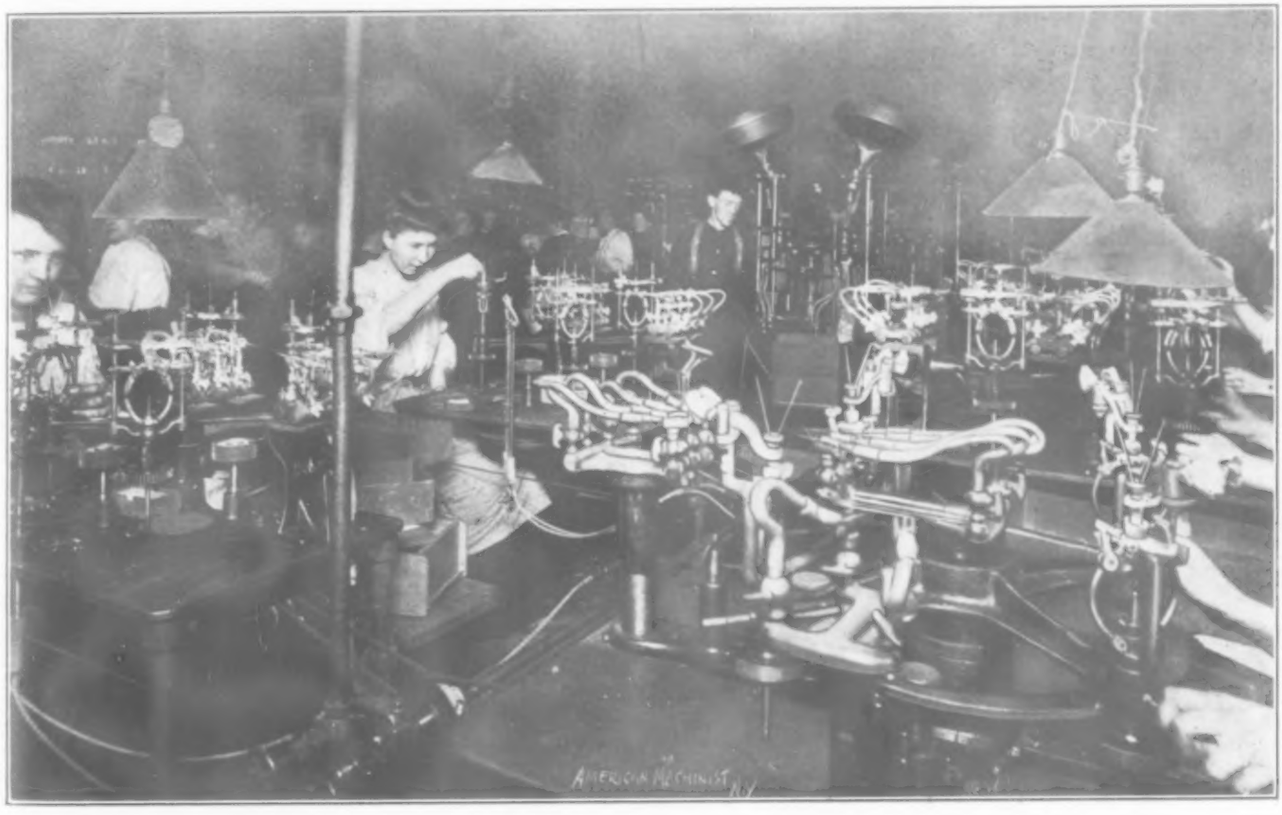


FIG. 1. MAKING THE STEMS. AUTOMATIC FLANGING MACHINES IN BACKGROUND AND FLATTENING MACHINES IN FOREGROUND. WESTINGHOUSE LAMP COMPANY, BLOOMFIELD, N. J.

with skilled labor a great many different automatic and semi-automatic machines of great interest.

The glass bulbs are usually bought by the lamp company from the glass blower, but they are received in a form which has to be considerably altered before the lamp is finished. The bulb turned out by the glass works has no tip on the large end while at the small end they are extended into a cylindrical tube about 2½ inches long by ¼ of an inch in diameter.

The lamp company makes the filaments, fastens them to the leading-in wires, mounts them, provides the bulbs with a small exhaust tube, flanges the small end of the bulb, seals it down over the filament and its mount, exhausts the tube, seals it off, puts on the bases and tests them, giving them their proper rating.

Filaments were formerly made of carbonized bamboo strips but are now composed of absorbent cotton, dissolved in chloride of zinc. This solution is violently agitated in a cylinder which is caused to revolve on two axes at once. This stirs up the mixture most thoroughly and when the machine is stopped, the mixture runs out at about the consistency of molasses. Due to the violent agitation, this sticky substance is full of air bubbles and its color approaches buff. The air is removed from the liquid by placing jars of it in connection with an exhaust system which draws the air out. After the air is removed, the mixture is still of a thick, sticky consistency but its color is now almost black.

The Filament Machines

This dark liquid is next formed into a thin thread by means of the filament machines. In these machines the liquid is held in glass bulbs into the top of which air pressure at from eight to ten pounds is admitted forcing the liquid out through the bottom of the vessel through a steel die, this die being exactly the correct diameter to give a thread, which after it has been dried and gone through the complete treatment to form a filament, will have shrunk to the size which is finally desired.

The fine stream of liquid which is squirted through the die drops down into a slowly revolving vessel containing wood alcohol. The revolving gives a peculiar twisting motion to the stream of liquid falling into the alcohol so that it is wound in the bottom of the vessel in a series of small loops. The action of the alcohol is to at once entirely remove the sticky texture of the liquid, giving it a tough elastic nature so that the loops lie smoothly upon each other without sticking together and there is no tendency to tangle, although many feet of this fine, flexible thread are wound in each machine. The filament thread which now resembles cooked

vermicelli is next wound on a large drum where it is allowed to dry for a few hours when it becomes hard and closely resembles a banjo string, although it is nowhere near so strong, being in fact rather brittle and easily broken.

In order to form the thread into the shape desired for the filament, bundles of these threads are wound on suitable formers and these formers are then heated for a short time, which sets the threads permanently into the form in which they are wound. After this they are cut from the former and baked for almost a week at a white heat, being packed in crucibles in layers of carbonaceous material composed of saw-dust, graphite and peat. This baking, which it should be said is done in two stages, the first heat being about cherry red and the final practically white hot, causes the filament to shrink heavily in both diameter and length and at the same time gives it a dense black color and a hard, brittle nature.

Flashing

The next process is termed flashing and the purpose of this is to give to the filament the uniformity of size and resistance necessary for the lamp. To flash the filament, it is held in a couple of clips which are connected to the electric circuit and suspended in a vessel which is alternately supplied with a hydro-carbon gas and then exhausted by means of a vacuum system. The clips holding the filament are part of the stopper to the vessel and when the filament is in place in the vessel, it is tightly shut off from the outside atmosphere and the vacuum is quickly produced by the pumps, while an electric current heats the filament to incandescence.

These flashing machines are of the semi-automatic character, as the valves leading to the hydro-carbon gas and to the vacuum system are operated one after the other by power mechanism and also the length of time that the filament is caused to carry the electric current while in the vessel is automatically controlled by an electric cut-out. The treatment actually deposits a small quantity of the hydro-carbon gas upon the filament by the action of the electric current and this deposit increases the diameter of the filament and consequently reduces its electric resistance allowing more current to flow through the filament the longer it remains in the rarefied hydro-carbon gas. When the resistance of the filament has reached the point desired, the strength of the current is such that it trips an automatic cut-out and shuts off the current. The whole operation is completed in an instant, one operator handling four treating vessels at a time. After treatment, the filaments are sorted according to their resistance, this resistance being measured very rapidly by electric instruments.

By closely examining an incandescent electric light bulb, it will be seen that the filament is supported in a short section of flattened glass tubing which projects up into the bulb. This piece of tubing is known as the stem and it will be further noted that the leading-in wires which carry the current to the filament are in two pieces. The part which passes through the glass is platinum and the purpose of this is to prevent leakage between the wire and the glass, because the co-efficients of expansion with heat of platinum and glass are almost exactly alike. The outside part of the leading-in wires which do not pass through the glass itself are made of copper, simply for cheapness. The copper and the platinum are held together by fusing.

The Automatic Stem Machines

Before the leading-in wires are fastened into the stem, the stem itself has to be made and the machine for making these glass stems is one of the most ingenious automatic devices which is employed in the manufacture of these incandescent lamps. Into a hopper at the top of the machine a large number of pieces of glass tubing about two inches long and 3/8 of an inch in diameter are put. By the rotation and vibration of the hopper, these tubes are caused to fall down a central duct of the machine, the tubes standing on end and following one after the other. At the bottom of the duct, four intensely hot needle flames are brought to bear on the lower end of the lowest piece of glass tubing, while at the same time this little piece of tubing is automatically gripped in a pair of fingers and made to rotate at high speed so as to uniformly distribute the heat of the flames around the bottom end.

When this bottom end has become red hot, the flames are automatically shut down, and while the tubing is revolving a small metal arm automatically rises and projects into the bottom of the glass tubing. The next motion causes this arm to lean to one side and bear against the red hot glass as it revolves. This pressure and the rotation of the hot tubing cause the bottom end of the glass to be flared out into a conical flange, somewhat like a small glass funnel. By the time the flange is formed, the glass is cool enough to again be hard, the arm drops away and the short piece of flanged tubing also drops down into a box underneath. Several of these machines are taken care of by a couple of operators, and as they form the flanges very rapidly a great number of flanged stems are turned out in a given time. These machines are replacing a large number of operators who used to make the stems by hand.

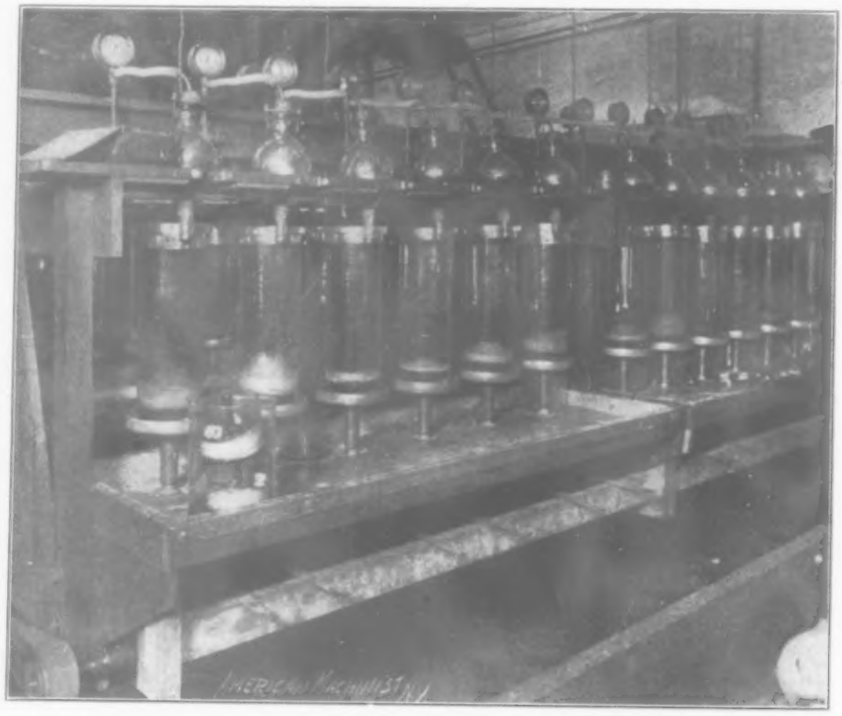


FIG. 2. THE FILAMENT MACHINE

The Leading-in Wire Machines

The next process, after the formation of the flange, which by the way will be on the socket end of the lamp, is to put in the leading-in wires. This is done in a machine which is semi-automatic. The little stems with their flanged ends are stood up in holders on a revolving wheel and an operator drops into the stem two leading-in wires with their platinum ends down and the flanged end of the stem up. The wires are set in so that they cross each other inside of the tube and the

platinum ends fit into a couple of holes in the block carrying the stem. As the wheel revolves, the stems are brought opposite a series of needle flames and at the same time caused to rotate on their own axes. The action of the flame is only on the bottom end of the stem which is opposite to the flanged end and as the glass becomes soft, it has a natural tendency to hug the leading-in wires and assume a flattened shape. After passing several of the needle flames, it is in a very soft condition and at this point two fingers rise automatically and squeeze the red hot glass so as to compress it flat against itself and at the same time entirely fuse in the little platinum ends of the leading-in wires, making an air-tight joint and completing the formation of the stem.

After this the filament has to be attached to the platinum end of the leading-in wires. This is done entirely by hand up to the present time and it is simply a matter of very skillfully pasting the ends of the filament to the platinum wires, a special kind of carbon cement being used, which is exceedingly sticky, dries rather rapidly and is also a good conductor of electricity. The paste is made of gum arabic, caramel and graphite.

Fusing on the Exhaust Tubes

The next operation is the preparation of the glass bulb to go over and be sealed to the stem carrying the leading-in wires and the filament. As before said, the bulbs when received from the glass blower have a considerable length of tubing at the small end, while at the large or round end they are perfectly smooth and do not have the sharp tip which is usually seen on incandescent bulbs. This tip is what is left of the small glass tube which was used to exhaust the air from the bulbs after they have been otherwise completely finished. It is, therefore, necessary to fasten on this small piece of exhausting tube, and this is also done by a very ingenious machine.

The bulbs are set in a frame directly over a very fine needle flame and at the same time compressed air at low pressure is applied to the small or open end of the bulb. The needle flame makes, of course, a soft spot in the round end of the bulb and the compressed air blows this outward, making a hole about ⅛ of an inch in diameter. Next the bulb is turned over and by means of a lever a short piece of glass tubing about 3/16 of an inch in diameter is brought down by a couple of fingers into contact with the small hole in the bulb and at the same time hot needle flames are automatically directed at the end of the tubing and around the rim of the small hole fusing the tube to the bulb. By another movement of the lever, the tube is slightly drawn upward to straighten it out and then both the bulb and tube are released and taken away to be replaced by others.

Flanging the Bulb

Before sealing in the stem with the filament, the bottom end of the bulb has to be cut off and flanged to fit the flange on the stem. To do this, the bulb with the open end down is put into a rapidly revolving holder between needle flames which literally cut off the excess glass at the bottom of the bulb, almost like a knife and this excess glass drops down into a waste box underneath. The flame also causes the bottom end of the bulb, where it has been cut off, to shrink together and actually close over the end of the bulb with a thin film of glass. The bulb is then raised up and the small tube at the other end is connected to a compressed-air pipe which blows out the softened end of the bulb while the glass is still hot and this blowing out forms another smaller bulb on the bottom, or small end of the main bulb. This new part, however, is of very thin glass and by touching it against the table all of this thin glass falls away, leaving a flare or flange around the opening in the main bulb, this flange being just about the correct angle to fit the flange which has already been made on the stem.

The bulb is now ready to have the

FIG. 3. FILAMENT TREATING

FIG. 4. BULB TUBULATING MACHINES

stem, with its leading-in wires and the filament, sealed in. To do this, the stems with their wires and filaments are stood up on pins around the rim of a revolving wheel, the bulb is carefully put down over the filament and the stem, and by the next motion of the wheel all the parts are automatically revolved on their own axes, while hot needle flames play on the flanges of the stem and of the bulb, causing the glass to partially melt and effectively seal the two flanges together in an air-tight joint. Just after coming out of this machine, an operator, who really acts as an inspector, gives a rapid adjustment to the still hot glass insuring that the stem has a correct upright position in the bulb.

Exhausting

The lamp is now almost complete and the next step is to exhaust the air from it. This used to be an expensive process but it has since been made very much cheaper and more effective. The old method was to use mercury pumps, exhausting a whole row of lamps at once and necessitating that they should all be exhausted exactly alike, whereas it has been found that some bulbs require a little more pumping than others in order to give correct results. The exhausting is now done with mechanical pumps which operate very much quicker and this improvement has been secured by the device of removing the last traces of the gas in the bulb by chemical precipitation.

To do this, the little exhausting glass tube in the round end of the bulb is treated on its inside surface with a phosphorus compound and this short piece of tubing is forced into a rubber connection in the exhausting system. Next a small flame is played against the tube causing the phosphorus to become vaporized and pass up into the bulb where it unites with the gases given off by the paste which holds the filament to the leading-in wires, which gases it has always, up to the adoption of this method, been very difficult to entirely remove by means of exhausting pumps. The uniting of the phosphorus with the gases causes a very minute deposit to be formed, thus making the vacuum almost complete.

The uniting of these gases also serves as a guide to the operator to determine when the exhaustion of the bulb has been carried to its limit, for the gases burn inside the bulb with a very pale blue flame until the action is complete, when the flame goes out, indicating that the vacuum has reached the desired point. Next a needle flame is played against the exhausting tube near the bulb causing it to melt and by twisting the bulb and drawing it away the glass is effectively sealed shut, making the lamp complete mechanically with the exception of the brass base.

Of course, all through the process of manufacture, a rigid inspection is necessary. This is made to see that the mechanical operations have been properly performed and also to see that the filaments are of the proper resistance and when burning are without spots. After the exhaustion there comes an inspection to determine the degree of vacuum obtained.

X-Ray Inspection

It is a peculiar fact that if a bulb is partially exhausted and if the glass is held in the hand of an experimenter while his other hand is connected to one terminal of the secondary of an induction coil, and the leading-in wires are connected to the other terminal of the coil, a blue flame will be produced inside of the bulb, this blue flame being none other than the often heard of X-ray. If, however, the exhaustion of the bulb is carried to a higher point, this flame grows dimmer and dimmer and a point of exhaustion is reached at which there will be no flame inside of the lamp.

Electric-light bulbs should be carried to the point of exhaustion where there will be no flame when thus treated, and in order to prove them, they are stood up in a frame, with the leading-in wires touching a metal plate which is connected to one terminal of an induction coil, while an operator who stands on another plate, connected with the other terminal of the coil, touches the bulbs one after the other with the hand. The good bulbs, that is, those properly exhausted, will give no flame, others will give a very slight flame of a delicate, pale blue, which if it is not too strong can be burned out by a continuance of the passage of the electric charge for a few seconds. If it does not burn out, the lamp is discarded. If it does burn out, it will be passed, although recorded as having exhibited a flame, while the perfect bulbs are taken away to be put into the perfect stock.

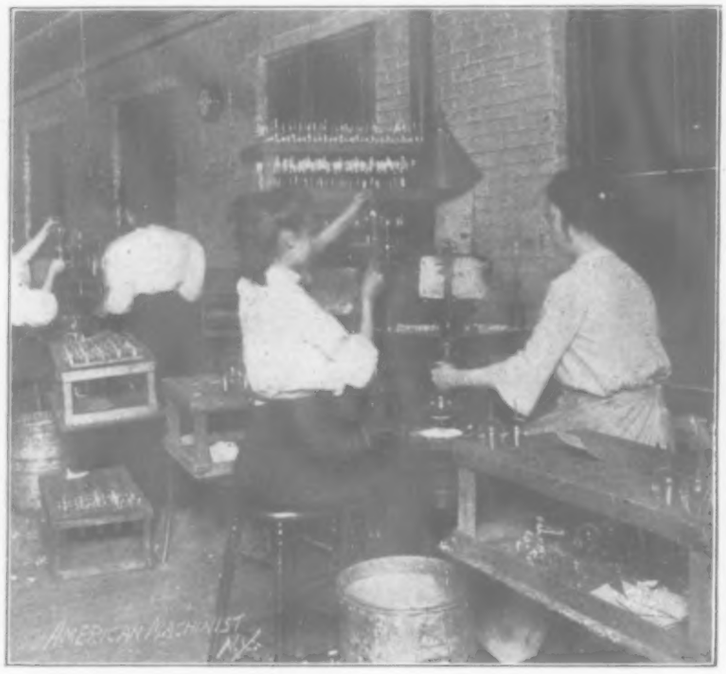


FIG. 5. SEALING IN THE STEMS AND FILAMENTS

FIG. 6. EXHAUSTING AND SEALING OFF

Rating by Photometer

After a final examination, the bulbs are next taken to the photometer room to be rated for voltage and candle power. The bulbs are designed to give a certain candle power on a certain voltage, but it has been found impossible to get the proportions so exact that it will give the exact candle power at the rated voltage.

and it is, therefore, necessary to test the lamps to find out at what voltage they will give the candle power desired. The range in voltage should not be more than five volts greater or less than the rating desired, and in order to obtain this small range, a great deal of care is necessary in the manufacture.

The determination of the right voltage is done by means of a photometer which is an instrument by which a light may be compared with a light of a standard intensity. This is done by projecting the light from each source upon a paper diaphragm having a grease spot in its center. If one light is stronger than the other, the grease spot will show as a light spice on the side next to the weaker light, whereas if both the lights are of exactly the same intensity, the grease spot will disappear entirely. In order, therefore, to test the new lamps, they are connected to a socket at a given distance from one of these screens, and on the opposite side of the screen there is a standard lamp also at the correct distance from the screen. The electric current is turned on to the new lamp, causing it to light up and by means of a resistance rheostat the operator adjusts the current to the new lamp until the grease spot on the diaphragm disappears. He then knows that the new lamp is burning at the same intensity as the standard lamp. When this result has been obtained, he reads the voltage from the voltmeter and another operator reads the amperes and marks both of these figures on the lamp in ink, thus establishing its rating.

The slight variation from standard voltages is no disadvantage for there is always this much deviation from the power-house voltage at different points in the elctric circuit.

When lamps are made in a factory, they are usually put into stock without the bases. This is because one customer may order lamps with one style of base and another customer would prefer another style. In order to accommodate all these various customers, the lamps are put into stock un-based and, as the orders come in, the bases called for are applied. In order to fasten on the bases, a cement is used and the bulbs are then set up in a revolving frame which carries them through a drying furnace.

The leading-in wires are soldered to the terminals of the base by an operator who uses what may be termed a perpetual soldering iron. This soldering iron is simply a piece of heavy copper wire upon which gas flames are continually playing while the operator touches the points to be soldered, to the end of this hot wire, the latter having, of course, been previously touched with solder. By this method the soldering is done very rapidly and at the same time a good joint is obtained. After a final general inspection, the lamps are packed in straw-board and in large wooden boxes to be shipped to the customer.

The first plant for the manufacture of liquid gas as a commercial commodity was established in Augsburg, Bavaria, in 1904, under a process invented by Herr Blau. Considerable success has attended the enterprise, a great many installations for heating and lighting having been made by the company in Germany, and some of the German railways have adopted it as a means of lighting passenger coaches.

High-speed Steel in Sammy's Shop

By W. Osborne

This high-speed steel proposition had been a troublesome one. When high-speed steel had first come into competition with the regular carbon steels and with the old reliable mushet it had not been hard to prove that a great advance had been made. The very first steel tried had been so good that it held its own with the next ones that came along. Its place had been determined by a consideration of the differences in price between it and the regular steels and for much of the work it became the standard. For a time everything was lovely, that is to say until a goodly part of the machine shop world woke up and went to using high-speed steel. When this took place the American steel makers began, one after another, to wake up.

It may be that our native steel makers were not really asleep. I am only stating the matter as it appeared to Sammy in his little corner of the universe, and as it concerned his shop. If they were not asleep they might as well have been so far as the user was concerned. The steels which gave evidence of somebody being awake were English steels and they were being pushed. One of these Sammy was using. To show how well one of these steels was pushed it is only necessary to say that at the present time the name of one of them is synonymous in the minds of a great many mechanics with "high speed."

In this little shop that Sammy was run-

FIG. 7. THE PHOTOMETER FOR RATING THE LAMPS

FIG. 8. REVOLVING OVENS FOR CEMENTING THE BASES

ning it was not the purpose to run it for testing steels. The object was to get out work. This point did not seem to be plain to the steel salesmen. Sammy made several tests and decided that the steel which he was using gave very good average results when compared with others, and then he settled down to getting out work.

Tests that mean anything take care and attention, and use up time, energy and money which might be employed to get out work.

"We are making the best steel that can be made. Down at Blank's we went up against that steel that you are using and made it look like less than thirty cents. I'll just send you a bar and let you test it out, and if you don't find it better than anything you have ever had send it back. You will not have to pay anything for what you used in making the trial."

Now wasn't that a generous proposition?

Sammy thought so once but has changed his mind. Here is how it worked out with him. A bar of steel came and also a sheet showing how it should be handled. It was tried and found better on some work and not so good on others. On an average it was not any better than the regular high-speed steel and the cost per pound was the same. Not wishing to stir up trouble the bar was kept and paid for.

By and by the agent again appeared and was ready to book orders for his high-speed steels and was very much surprised with Sammy's statement about his steel. Surely there was some mistake. Not only at Blank's but also at Double Blank's, and at Triple Blank's their steel had far surpassed everything else, etc. Sammy allows another bar to be sent because he lacks backbone.

To clinch the matter he watches this bar very carefully. Sees how the blacksmith handles it, and sees how it is ground and used in the shop. The results are certainly a little better than he has been getting. The next time that salesman comes around Sammy has to surrender and is loaded up with this steel.

Now having gotten the best his troubles are over. That is, they should be, but along comes another salesman who is traveling for another steel concern, and he has the same sort of a story, and tries to have Sammy go through the same performance. Sammy rebels and it gets to be a hard matter for a steel man to find him.

As time goes on he gets a howl from the maker of the steel that he used to use because they have not received any further orders.

He also begins to find out that the new steel when it has to take shop luck like the old steel did is not giving as good results as it did when being watched carefully as it was during the test, and that it is not as good as the old steel.

He returns to the old steel and sticks to that so tightly that even the offer of five cents a pound reduction on the price does not pry him off.

When the reduction gets to be fifteen cents a pound Sammy does some testing, because he has a friend who says that the cheap steel is the best steel in the market. Sammy found that it did his work as well as the higher-priced steel and it becomes his standard.

While Sammy does not want to turn the shop into a testing laboratory he does read some of the papers and the information comes to him that some of the steel makers could make a steel very much better than any now made if they wanted to, but that for commercial reasons they do not want to. He wonders if that explains some things.

Perhaps some of the steel makers are making high-speed steel because they have to, because of the demand, and it may be that they are not making it as good as they could make it but only as good as the leaders in high-speed steel making force them to make it.

While he is turning these things over in his mind along comes a salesman who proclaims that he has the identical steel that the papers have hinted at, and that it is many times better than even his own best before this time. The price asked is rather stiff: It eats up that fifteen cents a pound that Sammy had been saving for awhile back and takes a great big jump ahead of the old price.

As these people had been leaders in the first high-speed steel movement he orders a bar of the new *high high-speed steel* for purposes of comparison. Before that bar gets to him several steel salesmen call and he tells them about the new steel. One and all they make light of it. "It is all a bluff." "You might as well throw away the extra money you pay for that steel."

The new steel comes and makes good, and evidently it makes good in other places, for reports of tests made with other steels begin to appear very much as tests appeared when high-speed steel first came out.

Sammy would like to know whether the steel makers are again being forced as they were with the first high-speed movement.

An examination of the advertising pages of the AMERICAN MACHINIST for June shows that just two steel makers proclaim that they make the steel that surpasses former high-speed steels, not a few per cent., but from four to eight times in durability. He thinks it rather significant that these two were two that were leaders in the first high-speed steel movement.

By and by some steel salesmen will be trying to explain it all. A friend of Sammy's who is an imaginative sort of a fellow says that the steel men are seeing things, and that these things are scaring them. They fear the time when a boy will get a tool when he enters the shop to learn the business, and use it for everything that comes along, and stay in the business until he leaves to die of old age. Before he leaves he will give the tool its first grinding since he began to use it, not because it needs it but as an evidence of good faith, and pass it to his grandson.

In the meantime most of the steel makers will be in the poor house along with the doctors who are out of a job because some foolish ones have advanced the art of keeping well.

Perhaps the steel makers do not know that such specters have been scaring all sorts of people for a long time. The only real harm done has been the harm that came from the scare.

Gating and Molding Grids

BY SAM JONES

On page 744, of Vol. 31, Part 2, was an illustrated article on the elasticity of cast iron which, while interesting, did not cover the patternmaking and molding of the same and this is equally as interesting.

It is generally conceded by foundrymen who have made grids that this simple looking casting is very difficult to cast without heavy losses, unless they use special grades of sand and iron and employ skilled molders. As a matter of fact this is not so, for with any of our fine grades of sand, such as are used on bench work, and a properly gated pattern it is a very easy thing to make. The chief trouble with making this casting is in the gating and, like many other small pieces that foundrymen are daily having trouble with, it needs someone who will figure out what proportion of gate it requires, rather than for someone to say, in the guessing fashion, put a few leaders here and there and let me have it as soon as you can. Good skilled molders, after some loss, discover the mistakes and cure them themselves, and this has cost the foundrymen much, at such times as the skilled molders see fit to go on a strike.

The grid work I am describing here is done in a large foundry, near Boston, that makes nothing else. They contract for the work from large traction companies and to insure that they lose but little, and get the right grade of iron each day, they employ a chemist. The molding is all done on machines and by green men, but previously, skilled molders were used on this work.

These grids were made on the old-style roll-over machine, which could only take care of shallow work like this, that had considerable draft. Some operators put up 175 molds per day. The unskilled laborers employed soon learned how to make the molds, but had considerable trouble in pouring them. This was not so much their fault as it was the fault of the gating. One particularly heavy grid, shown in Fig. 1, was difficult to cast two

in a mold. The cause of the trouble was that it washed at point *G*, and this indicated that we should figure out the areas of the leaders *C* combined and the area of the sprue.

A Successfully Gated Grid

In Fig. 1 this grid is shown as it was gated and successfully used after a year's experimenting. Twenty-four feeders, as designated by *C*, were on each pattern. At the point of contact with the pattern they were 3/16x⅛ inch, which gave for the 24 a combined area of about 2.356 inches, and the sprue, which was ⅝ inch in diameter, had an area of only 1.963 inches. Thus it will be seen that in pouring, with only one in a mold, there was not a big enough sprue to feed them.

In a study of this mold, regardless of the gate, it will be seen that it consist of 23 long narrow walls of sand designated at *G*. These walls depend principally, for their strength, upon the binding in the sand that joins them to the sand on which they stand, and the face of the cope as it rests on them. The amount of strength required, when improperly gated, was such that no sand had enough binder in its natural state to hold against the uneven strain that was placed against it, when the molten iron ran up one, and not the other, of the channels that formed in between these walls. The only success in pouring that was obtained was due to very hot iron, a level mold and very gentle pouring.

Another trouble discovered in the patterns was that they did not have sharp edges at the parting line and were not absolutely straight along the back, so that when placed on a board they would leave a sharp corner in some places and a cavity in others. The cavity was filled up with wax and given a coat of shellac, but the wax would not stand the pounding the plate received on its back just before drawing the pattern.

Another mistake was the using of wood mold boards, as they would warp and cause the mold to show either a fin on the casting or a crush. These crushes would not always destroy the casting in a way that the eye could detect, but would make the casting thinner. This was not serious until it reached the place where it was to be used (under trolley cars), then it would burn out and possibly destroy several others.

The pattern of the grid, shown in Fig. 1, being made of brass, was cleaned up and soldered on a true brass plate which, in turn, was bolted to a hardwood board with heavy battens on the under side. Each wall or rib of the pattern was pinned down and soldered, and a very fine fillet put at the bottom to give the sand strength where it needed it, and also to prevent the mold from cracking at this point. The battens were set far enough apart to allow two parallel gates *B* to be set in between them, about three-eighths of an inch from the pattern. Connecting these gates and the two patterns were 48 feeders *C*. These feeders were made out of half-round 3/16-inch brass rod firmly soldered in place. The two gates were connected in the middle by two pieces *D* and *E*, *D* being for a dash basin to offset uneven pouring and *E* a locating spot for the sprue. Through it is a hole that accommodates the pin on the end of the sprue. This hole goes clear through the pattern plate to always keep it clean.

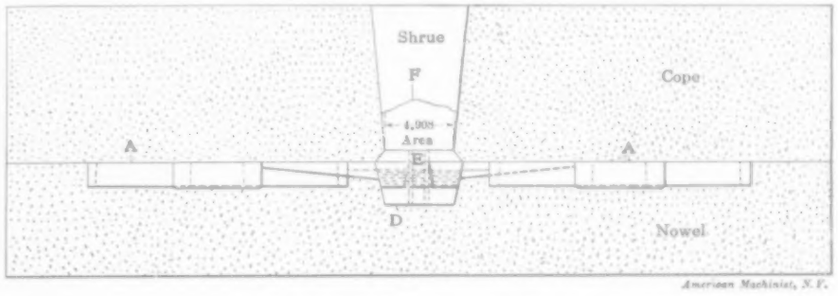


FIG. 2. SECTIONAL VIEW OF MOLDED GRIDS

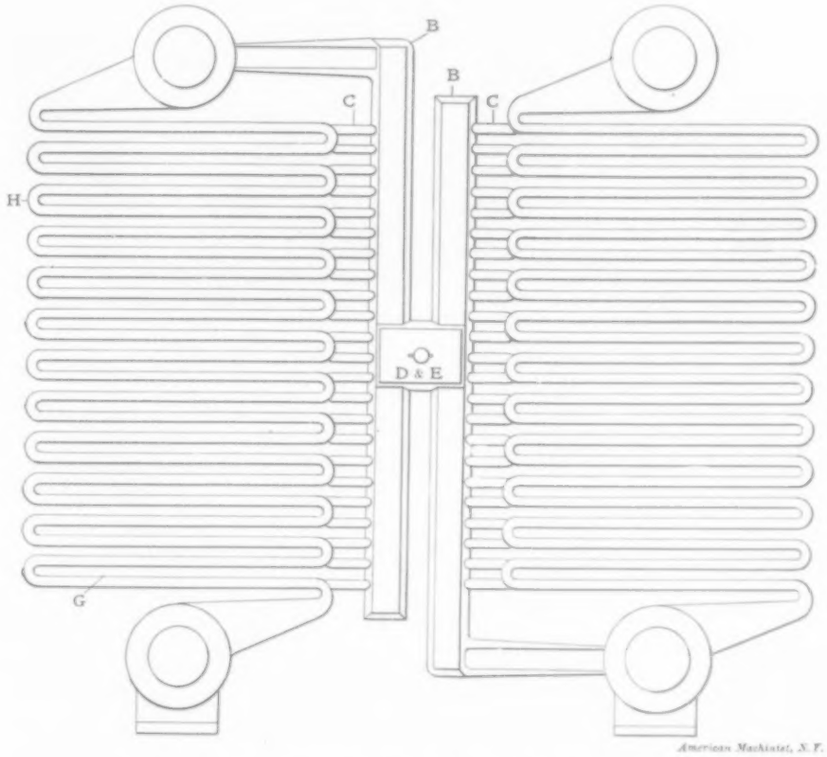


FIG. 1. TWO GRID PATTERNS WIT H GATES AND FEEDERS ATTACHED

In pouring this mold, as shown in Fig. 2, the iron would first fill up the dash basin and overflow into the gates *B*, which, when filled to a certain hight, would overflow into the 48 feeders and send a sheet of molten metal into the mold up the 48 channels *C*, in an even state until they meet at the end point *H*.

The total area for the 48 feeders was 4.712 inches and the area of the sprue was 4.908 inches. Thus it will be seen that the sprue would nicely take care of the 48 feeders without any efforts of the molder. The sprue was a little larger than was really necessary, but it was better to be too large than too small, as it might cause bad casting.

A good example of the economy often accomplished by chemical investigation and discovery is furnished in the case of ultramarine. Many years ago when this was made by powdering the mineral lapis lazuli, it sold for more than its weight in gold. Now that the chemist has discovered how to make the same material from such cheap substances as kaolin, sodium sulphate and carbonate, charcoal, sulphur and rosin, the price is only a few cents per pound.

Permanent Molds for the Foundry*

Materials for Molds and Cores, Effect of Molds on Castings, Effect of Molten Iron on Molds, Temper of Castings and Their Machining Qualities

BY EDGAR A. CUSTER†

It is the purpose of this paper to give a full and free account of the conclusions formed after three years of constant work on the problem, and it deals solely with work that is applicable to permanent molds, and the statements made and conclusions formed are directed only toward that branch of the foundryman's art.

The subject may be taken up under the following heads:

(1) Of what material should the molds be made?

(2) What effect has such a mold upon the castings?

(3) What effect has molten iron upon the molds?

(4) What remedy should be applied for any bad effects shown?

These four points having been carefully considered, and the efficiency of such a mold conclusively demonstrated, the value of the permanent mold for certain classes of work is established.

The ideal material for permanent molds would be one that would not chill the molten iron, would stand swift heating and cooling without disintegration and would be capable of being machined or molded into the shape required. This material should be very nearly as hard as iron, quick to conduct heat and of low specific gravity.

Materials for Molds

There are a number of substances that fulfil these requirements in part. Lava rock will stand the sudden changes of heat and cold, can be cut into the shape desired and does not chill the molten iron. When a coating of finely ground mica, or some other inert substance, is rubbed into such a mold it will give beautiful castings. But it wears away rapidly, and soon needs renewal. Were it not for this fault it would very nearly solve the problem. We found it extremely difficult to handle and prepare this substance, and this led us to seek a material that would possess both hardness and ability to stand the heat changes. Cast iron has been the favorite medium, and so far, nothing has been brought forward that is so well adapted for foundry work. It has the advantage of being easily machined, and the added advantage that it is formed by a process with which we are all familiar, while its possible disadvantages are more easily overcome than those of any other substance.

It is not much trouble to make and machine an iron mold, and we can calculate the expansion and contraction to a nicety. Its great drawback is its chilling effect. Some investigators make the claim that if the mold is heated to nearly the temperature of the casting when it is ready for removal, no chilling effect is perceptible; also that the molten iron should cool at the same rate in a permanent mold as it does in a sand mold. To both of these propositions I would answer that they defeat the object of permanent mold work, in that they destroy the permanence of the mold, confer no benefit on the finished product and set up a multitude of difficulties, such as core-crushing, shrinkage strains, and segregation.

Disintegration and Distortion of Iron

We are all familiar with the rapid disintegration of cast iron when kept at a very dull red heat, the rapid oxidization and the tendency to spawl and crack. When the heating and cooling is carried through a range of 200 or 300 degrees Fahrenheit,—and this must of necessity occur—the mold becomes useless in an incredibly short time. Again, the molten iron will not lie close to such a mold, and the resulting castings are far from perfect.

Mold distortions due to heat become permanent after a temperature of 900 degrees Fahrenheit has been passed, so that highly heated cast-iron molds seem to be out of the question. While there is no doubt that they would prevent chilling, the cost of such a method would be prohibitive.

Should the iron cool at the same rate in a permanent mold as it does in sand? The answer to this is most emphatically in the negative. The effect on the mold would be the same as maintaining it at a high heat, and the time lost in cooling would slow the process up materially. Slow cooling would not improve the casting, nor would it prevent segregation. It would induce shrinkage strains, and in fact would be no improvement over the present sand-casting method, except that it would obviate sand ramming.

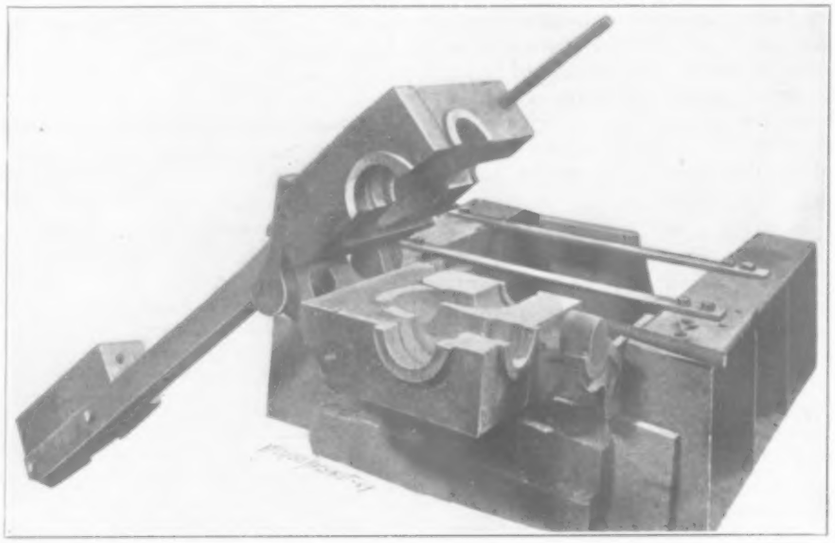


FIG. 1. A 4-INCH TRAP MOLD, CASTING WEIGHS 42 POUNDS

Effect of Mold on Casting

When we first contemplated using permanent molds, similar to those shown in Figs. 1, 2, 3 and 4, it was considered a foregone conclusion that unless the interior of the mold was heavily coated with some inert substance, the casting would necessarily be chilled, and extensive arrangements were made to prevent or to remove this chill. For a time the molds were carefully coated after each pouring, but, in our efforts to gain time, this coating was neglected, and we noticed that even when this was the case no chill appeared, provided the casting was removed above a certain temperature.

Following this lead we found that when the surface of the mold was practically

*Abstract of paper read before the American Foundrymen's Association at their meeting in Cincinnati, Ohio.

†President, Tacony Iron Company, Philadelphia, Penn.

free of any coating, no gases were formed by contact of the molten metal, and that chill could still be prevented by removing the casting at the proper temperature.

Once these facts were thoroughly established all our attention was centered on the possibility of removing the casting as soon as it was set. A few trials proved beyond doubt that molten cast iron does not chill until after the casting has set, and it was simply a question of reasonably quick work to produce castings not only perfect in form and texture

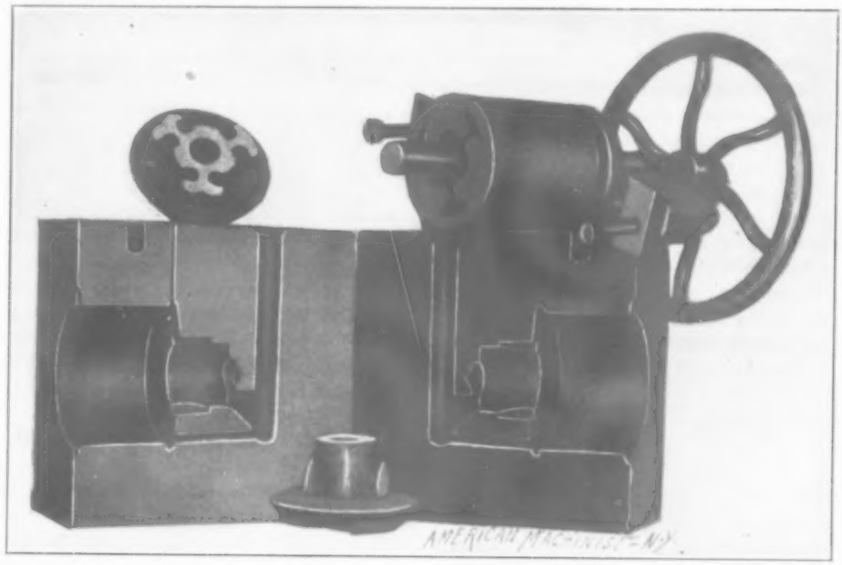


FIG. 2. IRON MOLD FOR IRREGULAR CAM CASTING

but answering all the requirements for high-class marketable work.

Metal Cores

If the contact with comparatively cold iron on one side, did not necessarily chill the casting, then contact with iron on both sides need not chill it. To demonstrate this point several thin sheets were cast between heavy plates and removed without chilling. This suggested the possibility of using metal cores, provided these could be removed before being caught by the shrinkage and immovably held or the casting cracked.

Reasoning that cast iron does not contract until after it is solid, we believed that it would be possible to remove a core before such contraction occurred. This was tried first on the T-shaped fitting, the entire core being made of cast iron, in two parts, as shown in Fig. 5, one part for the main body and one part for the branch. These core parts were fitted to the mold and metal was poured around them, and it proved to be not only possible but very easy to withdraw the core, provided it was done when the casting was at the proper temperature. Nor was the allowable time for the withdrawal of the core so short as would be expected. In fact, it was necessary to wait a few seconds after pouring, before removing the core.

Size of Cores and Molds

If, then, an iron core could be easily withdrawn from a tube one foot long, it was possible that it could be withdrawn from a tube 5 feet long. This was attempted, and repeatedly accomplished, a four-inch pipe 5 feet long being cast on an iron core and the core removed before being gripped by the contraction of the pipe. The pipe and its core are shown in Fig. 6.

We found by these trials that no gases were formed other than those from the air in the mold, and if this air was allowed free vent no trouble was experienced in filling a mold of any shape or size, and in removing the resulting casting at such temperature as to avoid white chilled crystals.

It is almost impossible to formulate any set rule as to the size and shape of molds for various castings. The one general rule of allowing a surplus of metal in every case seems the best practice. This is, of course, very indefinite, and experience only will show what is best.

The mold shown in Fig. 1, in which a trap was cast weighs 1700 pounds, and the 2-inch tee mold, shown in Fig. 7, confesses to over 500. The advantage of providing a large bulk of iron is too great to be ignored when it is considered that the objects desired are not only to swiftly remove the heat from the molten iron but also to provide enough metal to store this heat and resist the tremendous strains imposed.

Effect of Thin-walled Molds

In using these molds we take no precautions against shrinkage. We depend altogether upon the fact that chilling molten iron swiftly to the point of setting makes castings that are homogeneous, and thus the shrinkage strains due to irregular cooling are reduced to a minimum. The main object to be accomplished is to secure rigidity of the mold in all its parts—there is always time enough to remove the casting and retain the shape given it by the firm, unyielding surface.

A mold that has thin walls,—1½ or 2 inches thick—will spring away from the molten iron under the influence of the intense heat, and the casting will invariably follow the spring. Molten iron, like

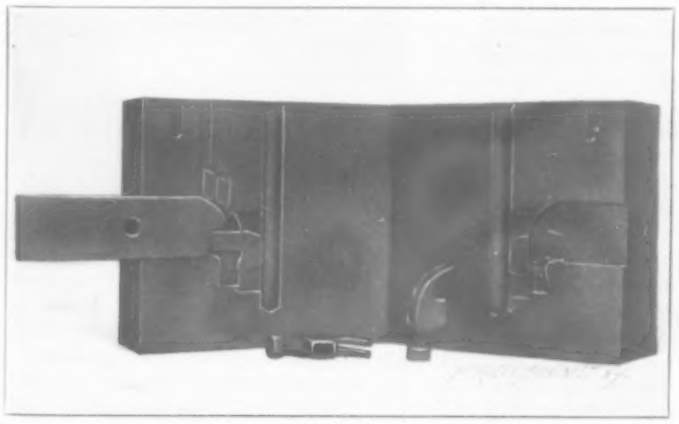


FIG. 3. MOLD FOR CLAW HAMMER. IRON CORE IN PLACE

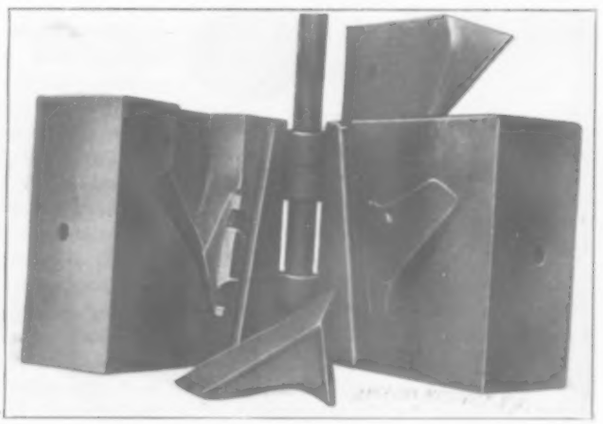


FIG. 4. MOLD FOR PLOW POINT

water, moves in the line of least resistance. Its peculiar property of increasing in bulk when passing from the molten to the solid state makes it possible to get a casting that fills every crack and cranny of the mold so long as this tendency to swell is successfully resisted.

This same mass of iron in the mold, by reason of its rigidity and its capacity for quickly transmitting and storing heat, will greatly lessen the liability to cracks in the mold cavity. The only place where any deterioration sets in is where the molten iron strikes in the gates, and our experience has shown that we can safely neglect this item.

Life of Molds

How long a cast-iron mold will last has not yet been determined. So far, we have made over 6000 pieces in a single mold, and it is in better shape now than when we started. Our statistics show that the life of the mold depends, not upon the number of pourings but upon the number of times the mold is allowed to become entirely cold and then reheated. Continuous pouring, when correctly timed so as to preserve a generally even temperature, has but a very slight tendency to crack the mold. It is only when it is allowed to cool that the cracking becomes at all noticeable, and then only in the

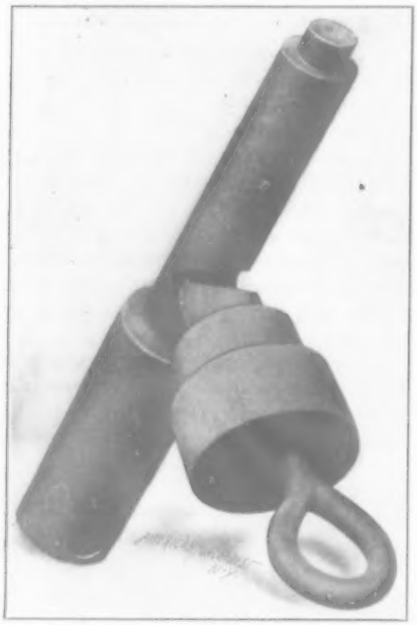


FIG. 5. CORES FOR 2-INCH T USED DAILY FOR OVER 7 MONTHS

gates; a sample of which is shown in Fig. 8.

Temperature of the Mold

We have found that a good casting can be made in a cold mold without any trouble, provided the mold is perfectly dry. But the tendency of the iron to condense moisture from the atmosphere when heating up is so great as to make it almost impossible to get a good casting unless the pouring is done rapidly, so that the mold will be filled before the moisture is deposited upon the face of the mold.

In a perfectly dry atmosphere, with a cold mold, the iron pours readily and makes a very fine casting. The only reason it is desirable to have the molds warm is that they will then keep perfectly dry. We would much prefer to do all our work with a mold at a temperature of not more than 125 to 150 degrees Fahrenheit. As a general rule the first casting is not a very good one, but after the casting has warmed up the mold, there is no further difficulty.

In order to preserve an even temperature in the mold it becomes necessary to put enough weight into it and pour the castings at such intervals that the temperature will not rise over a certain number of degrees. For instance, we found that casting a four-inch pipe weighing 65 pounds in a mold weighing 6500 pounds, every seven minutes, does not raise the temperature of the mold to more than 300 degrees. This matter of heating depends altogether upon the thickness of the casting, and the molds must be designed with that particular point in mind.

Permanent Core

The use of a permanent core is necessarily limited to castings in which the core is either in a straight line or is in a regular curve. Combinations of straight lines, such as in T's or Y's, or double T's or double Y's or straight pipes, are especially adapted to this feature. When the core is in the shape of a regular curve, or combination of a straight line and regular curve, it can be made in two or more pieces and easily withdrawn from the casting. This can be done in the case of L's, or sweeps. Irregular curves or cores that would be destroyed in removing them from the casting are, of course, not possible.

We have found that the best metal for these cores is ordinary cast iron, and that the same method of procedure must be carried out for the core as with the mold. There is plenty of time to remove the core and open the mold and yet have the casting without any hard spots. The use of permanent cores suggests the possibility of a machine for duplicate work that is to be made in large quantities, and this machine can be practically automatic in its operation. Pipe fittings, chain links, and elevator buckets might possibly come under this class. This is, perhaps, looking rather far into the future, but it is the logical outcome of the successful carrying out of the principle involved.

Steel versus Iron Cores

It should be just as possible to remove a 12-foot core from a water-pipe as one 5 feet long. It is only a question of apparatus large and powerful enough, and removing at the proper speed. Cores made of steel and wrought iron have been tried, but give very poor results. The cast-iron cores require considerable attention for the first few pourings, to prevent burning and distortion, but after a few castings have been made the iron seems to become seasoned, and after 50 or 100 castings have been poured, very little care need be taken in regard to overheating the arbor or burning it by the impact of molten iron.

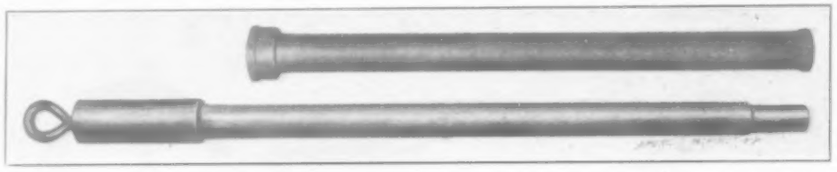


FIG. 6. A 4-INCH PIPE AND ITS PERMANENT CORE

Soft cast iron seems to be the best medium for both molds and cores. It cracks less, and is not liable to distort, as is the case with a casting made of low-silicon or very close iron. It may be that this is due to the fact that a high-silicon iron melts at a much higher temperature than iron containing a low percentage of silicon, and consequently requires a higher temperature to reach the point at which it softens.

Temperature of the Iron

In all cases, when using permanent molds, the iron as it comes from the cupola should be very hot, and should never be allowed to stand any length of time before pouring. The first element it loses in cooling is carbon, especially if there is considerable silicon in the original charge. Iron at 2100 degrees Fahrenheit, with 2.5 per cent. silicon, will not hold as much carbon in solution as it will at 2400 degrees Fahrenheit, and it is the carbon we wish to preserve. In fact, it is almost impossible to make a very thin casting in an iron mold, with iron containing 2.75 silicon and low phosphorus and sulphur, unless the iron is very hot.

Our work has shown us conclusively that the best results are obtained with iron containing over 3 per cent. carbon and about 2 per cent. silicon. Again, the higher the temperature of the initial iron, the more time there is for the removal of the casting, and the longer shrinkage is delayed. The importance of hot iron is therefore evident, although there is but little loss of carbon when the silicon does not exceed 2.25 per cent. and ordinary diligence is used in pouring.

To Prevent Casting from Sticking

Some care must be exercised to prevent the casting from sticking in the mold. It is sufficient to coat the mold occasionally with a mixture of thin oil and graphite. There is no virtue in any of the many coatings recommended other than keeping

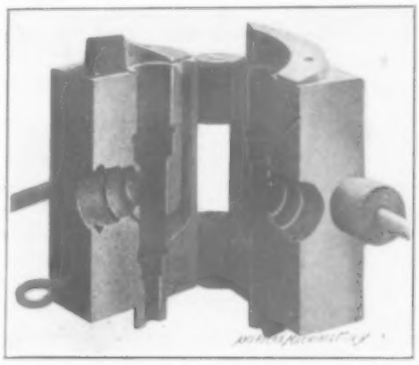


FIG. 7. A 2-INCH T-MOLD USED OVER 7 MONTHS

the molds smooth and preventing the castings from sticking. None will prevent chilling, unless laid on in such quantities as to form a substantial wall of inert material. I have used almost every available substance in an infinite number of mixtures, with but indifferent results. Mica, lithophone, clay, graphite, molasses water and clay, paraffin with any number of materials, have been tried, but one and all require a coating at each cast, which is out of the question in rapid work.

A thin solution of wood alcohol and shellac, thickened with finely ground clay, when applied to a slightly warm mold

FIG. 8. CRACKS IN A GATE

will usually prevent chill, but here again the mold must be cleaned and recoated for each casting. Silicate of soda when fused to the mold has but a very short life, and amorphous phosphorus has an entirely undeserved reputation in the line of chill prevention. The best way to prevent a chill is to take the casting away from the mold before the chill sets in.

That this chilling does not take place until after the iron has been set sufficiently to handle was demonstrated by a small sample casting made especially for the purpose. One side of this casting was soft and the other chilled. The quality of the iron in the unchilled portion was of the highest character, and the facility with which it can be machined is shown in Fig. 9, by the section of pipe on which some threads have been cut.

This sudden chilling to the point at which the molten iron sets produces an iron that is as nearly homogeneous as it is possible to obtain. That it is entirely free from shrinkage strains is shown by a casting that was taken from the mold at a bright red heat and thrown into cold water. It was absolutely sound and free from all cracks, surface or otherwise.

Contraction and Expansion

Now, what peculiar molecular action is set up that produces this result in an iron that when cast in sand exhibits all the defects we are accustomed to see in sand molding? To get at this explanation we must begin with the great unmeasureable force of heat contraction and expansion. No one knows how many tons per square inch is exerted when molten iron cools. This force is always greater than the tensile strength of the material under treatment. If, now, molten iron be subjected to this enormous force exerted through the mold, swiftly robbing it of its heat, it probably follows that the molecules are crushed together with an enormous pressure, and since this action is a matter of a few seconds at the most, there is no chance for segregation, and the impurities remain in the same relative position in the casting that they occupied in the molten iron. That this peculiar action continues after the casting has been taken from the mold is shown by the small globules of iron that have been squeezed from the casting as it cooled. It is further shown by a bar of 1⅛-inch iron that was taken from the mold at a bright yellow heat, with the interior still molten. Excrescences on the top were formed as the bar cooled in the atmosphere, similar to those shown on the pipe T in Fig. 10, and a broken section showed that the bar was of equal hardness throughout.

Temper of Castings

Now, let us go a step further. It has been found that iron when cast in an iron mold and removed as soon as it sets, possesses some unusual properties. For one thing it will take a temper, and when tempered will retain magnetism. If the casting be taken from the mold at a bright red heat and suddenly quenched in cold water, it has all the cutting power of a good high-carbon steel. This result is invariably obtained whether the iron be high or low in silicon, phosphorus, sulphur or manganese. There is no evidence of what we generally speak of as "chill"—no white crystals are shown; in fact, an iron that chills white first in the mold and is then quenched in water will not harden in the manner described but will crumble when applied to the emery wheel.

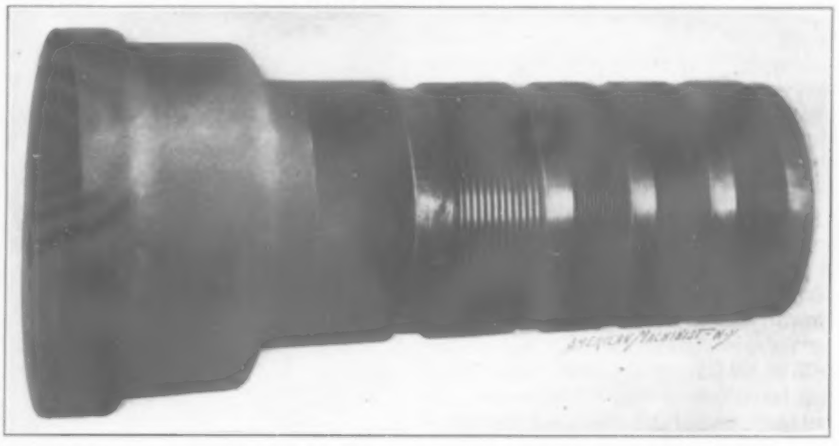


FIG. 9. THREADS FROM 8 TO 32 PER INCH CUT ON PIPE CAST IN PERMANENT MOLD

Chilling molten iron swiftly to the point of setting, and then allowing it to cool gradually, produces a metal that is entirely new to the art. It has all the chemical characteristics of cast iron, with the exception of combined carbon, and it also possesses some of the properties of high-carbon steel. We have been taught that steel will not take a temper when it contains a very appreciable amount of free carbon, yet this piece of cast iron, that has 0.44 per cent. combined, and over 2 per cent. free carbon, has been tempered repeatedly and will do better service in a lathe than a very good nonalloy steel. Once this peculiar property is imparted to the casting, it is impossible to eliminate it except by remelting. A bar of iron so treated can be held in a flame until the metal drips from the end, and yet quenching will restore it to its original hardness.

Analysis of Treated Iron

The analysis of the piece of iron treated as above is as follows:

Si	2.28
Phos.	1.21
Sul.	.108
Mn.	.41
T. C.	2.65
C. C.	.44

An analysis of another piece shows:

Si.	2.24
Phos.	1.12
Sul.	1.01
Mn.	.38
T. C.	3.02
C. C.	1.54

It will be noticed that the carbon for the first piece is low—much lower than we like to have it for our general work. But the remarkable feature about this particular phase of the process is that such a close-grained, tough and strong iron should be produced with an analysis such as given above. The analysis of this iron taken after it is removed from the mold, and without quenching, is the same as above, except that the combined carbon is not over .28.

The character of the iron before being quenched, is very fine, close-grained and yet it is easily machined. In all this work there are no blowholes, and any dirt that enters into the piece must come from the ladle.

Changes in the Carbon

All the carbon in molten iron is in solution, and exists in the combined form. Now, if molten iron be instantly cooled to 1000 degrees Fahrenheit all the carbon will be held in the combined form—there will be no free carbon. If, however, it be instantly cooled to the point at which the iron sets, and then allowed to cool normally, the carbon will be in the combined form at the time of setting, but will change to the free form as the cooling progresses. This formation of free carbon is very rapid; the major portion present in the casting is formed within a few seconds after it is taken from the mold. The analyses below give a very fair idea of this action, the pieces in question being 6x1¼x½ inches:

	C.C.	T.C.
Cast in sand and cooled normally	0.27	3.20
Taken from permanent mold at bright yellow and quenched	1.50	3.02
Taken from permanent mold at bright red and quenched	0.49	3.10

It will be seen from this that two-thirds of the combined carbon has been changed in the few seconds required to cool from a bright yellow to the bright red. The free carbon in all these castings is not in the form of graphitic carbon, as we usually see it in ordinary cast iron, but partakes more of the character of annealing carbon. It is probably this annealing carbon that gives the permanent mold castings their unusual strength and toughness.

Sulphur and Phosphorus

Our present-day technical journals, with their earnest and persistent work, have gone far toward making the foundryman's art a scientific process. We read a great deal about the evils of sulphur and of phosphorus, and we find that these evils are not exaggerated when it comes to making castings in sand. But to my mind, the reason why phosphorus and sulphur are the bane of the foundryman's existence is not because of the mere fact that sulphur and phosphorus are present in the casting, but because in slow cooling in sand molds, sulphur and phosphorus segregate. Therefore, the great evil in cast-iron work is not so much the presence of impurities, but the fact that segregation allows these impurities to mass themselves and thus destroy the homogeneity of the iron.

Our experiments have shown that an iron containing 1½ per cent. phosphorus when cast in an iron mold is as strong as

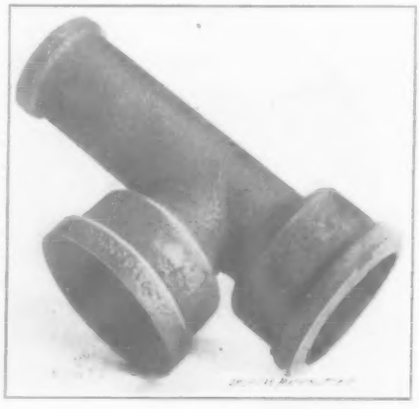


FIG. 10. SHOWING GLOBULES OF IRON ON SURFACE OF CASTING

iron containing 0.4 per cent. when cast in the same mold. We can find no perceptible difference in the tensile strength under these circumstances. The same is true with sulphur at 0.1 and sulphur at 0.03, and it would seem, therefore, that the mere fact of the presence of sulphur and phosphorus in these irons is not deleterious when segregation is prevented.

Segregation

It is not within the province of the sand mold to prevent segregation, and the remedy cannot be looked for from that point; nor is it possible to prevent a certain amount of segregation in a permanent mold when the casting is so thick in section as to make the cooling comparatively slow. Most of the work to which the permanent mold is applicable is not more than 1 or 1½ inches in the thickest part, and when a casting is not thicker than this and is made in a mold properly designed, there will be absolutely no segregation.

The formation and segregation of graphitic carbon is familiar to all, and its weakening effect upon cast iron is very well known. The casting made as above described, and containing free carbon that is thoroughly distributed throughout every portion of the iron and is not allowed to collect in large flakes or bunches, will be as easily machined and will have greater tensile and crushing strength than a casting made in a sand mold in the ordinary way.

Use of Iron Direct from the Blast Furnace for Making Casting

So far, we have discussed simply the use of the permanent mold as applied to the foundryman's art, with iron taken from the cupola. If, then, permanent molds can be used with success in the foundry, and a system of continuous pouring be inaugurated which in duplicate work would obviate the necessity of having molders, why is it necessary to melt pig iron in the cupola? What could be more ideal than a series of permanent molds supplied with molten iron practically direct from the blast furnace? The interposition of a reheating ladle such as is used by the steel makers of today, presents no unusual features; and this ladle makes possible the treatment of the molten iron.

Modern practice has eliminated much of the uncertainty in blast-furnace work, and it is not unusual to find these furnaces so equipped as to produce an iron that varies but few points from the quality desired by the foundryman. The molten iron we get from the blast furnace is much hotter than that obtained from the cupola, so that there is every reason to believe that the castings we would obtain would be of a better quality than when the pig is remelted in the cupola.

In our work we have conclusively demonstrated that it is immaterial whether an iron contains 1.75 or 3 per cent. silicon, so long as the molten mass is at the proper temperature, so that the high temperatures obtained from the blast furnace would go far toward offsetting the variations in the impurities. Given, therefore, a furnace properly equipped and properly handled, with the interposition of a reheating ladle, there is no reason why a very high class of work should not be obtained with the use of permanent molds. How far this thought can be carried out lies with the blast-furnace owner.

In a paper presented to the Franklin Institute, it was pointed out that while electricity holds an important place in the transmission of ships' signals this place is secondary as regards the movements of the vessels for the signals necessary to navigation and manœuvering are performed mechanically. The control of the main propelling engines from the bridge or pilot house is accomplished by mechanical transmitters connected by bronze wire to receivers in the engine room.

The Producer Gas Plant of the Philadelphia Gear Works

While the AMERICAN MACHINIST has drifted away from the power end of the machine business, still anything which results in cheaper power will no doubt interest those responsible for shop economies.

In Philadelphia rented power in a building having its own steam power plant costs tenants from 50 to 60 dollars per horsepower per year.

When I first knew the Philadelphia Gear works years ago that was the kind of power they had. Later they moved to another building and were here also dependent upon the landlord for power. The steam plant was an old one and the engine and boiler were shut down for repairs so often that Mr. Markland, the superintendent of the Philadelphia Gear Works, bought a gas engine so as to be independent of the landlord's decrepit plant.

Later on another move was made to their own new building at the corner of Vine and Marvine streets, Philadelphia and the plant here at first was run with a gas engine with city gas as fuel.

City gas in Philadelphia costs $1 per 1000 cubic feet. Allowing 20 cubic feet of gas per horsepower per hour (a very low estimate) this would give a cost of 2 cents per horsepower-hour of 50 cents per hour and $30 per week for a 25-horsepower engine, which was the size of the engine used with city gas.

The item of attendance with an engine of this size is very small and will not here be taken into consideration.

While the coal consumption in large steam plants has been brought down to a trifle over a pound of coal per horsepower-hour it will be found that the average 25-horsepower plant will take about 6 pounds per horsepower hour, say 5 tons per week at a cost of $4 per ton or $20 per week. Added to this is the cost of an attendant, who would in a plant of this size do his own firing, and whose wages would probably be about $12 per week. The cost of removing ashes and the incidentals of oil, waste, etc., need not be detailed here.

In favor of the gas engine we have no regular attendant and no coal or ashes to handle. On the other hand so far as I have been able to learn the waste heat from the gas engine has never been utilized for heating. And it is doubtful if there is sufficient sensible heat in the waste gases to make them available for this purpose.

With the steam plant, however, after the steam has done its work in the engine it still contains sufficient heat to make it available for heating the shop and if used in a properly designed heating plant is usually more than sufficient for the requirements.

The present power plant of the Philadelphia Gear Works is a 50-horsepower gas engine using producer gas. The engine and producer were both made by the Du Bois Iron Works, Du Bois, Penn.

This type of power plant seems to be the ideal one as regards low operating costs. The fuel used in the producer is anthracite buckwheat coal which can be bought in Philadelphia for $3.50 per ton. While the engine is capable of developing 50 horsepower only 30 to 35 horsepower is at present used. The economy shown is, therefore, not as great as it would be with the full load, but it compares favorably with either steam or city gas. With this engine the attention necessary is not more than required with an engine using city gas. The producer requires slight attention as it must be recharged about every two hours. This takes say ten minutes or roughly an hour a day. All the operations are simple and require no special skill.

To produce from 30 to 35 horsepower per week the coal consumption is less than two tons per week and the coal bill less than 7 dollars per week.

If the plant were run at full load the consumption would be proportionately less and in larger engines lower still and while the makers guarantee a horsepower-hour per pound of coal their engines have done considerably better than this.

I have roughly compared the cost of power with city gas at $1 per 1000 feet and producer gas made from coal at $3.50 per ton but even in the natural-gas belt, with natural gas at 20 cents per 1000 and coal at $4.50 per ton, a 50-horsepower producer and engine will show a saving in favor of the producer plant.

The Du Bois Iron Works is located at Du Bois, Penn., in the natural-gas belt with natural gas obtainable at 20 cents per 1000 feet.

One would imagine with gas at this price that it would be a waste of time to try to lower the cost of power. However, there is at the Du Bois Iron Works a 50-horsepower engine which was formerly run with natural gas as fuel but which

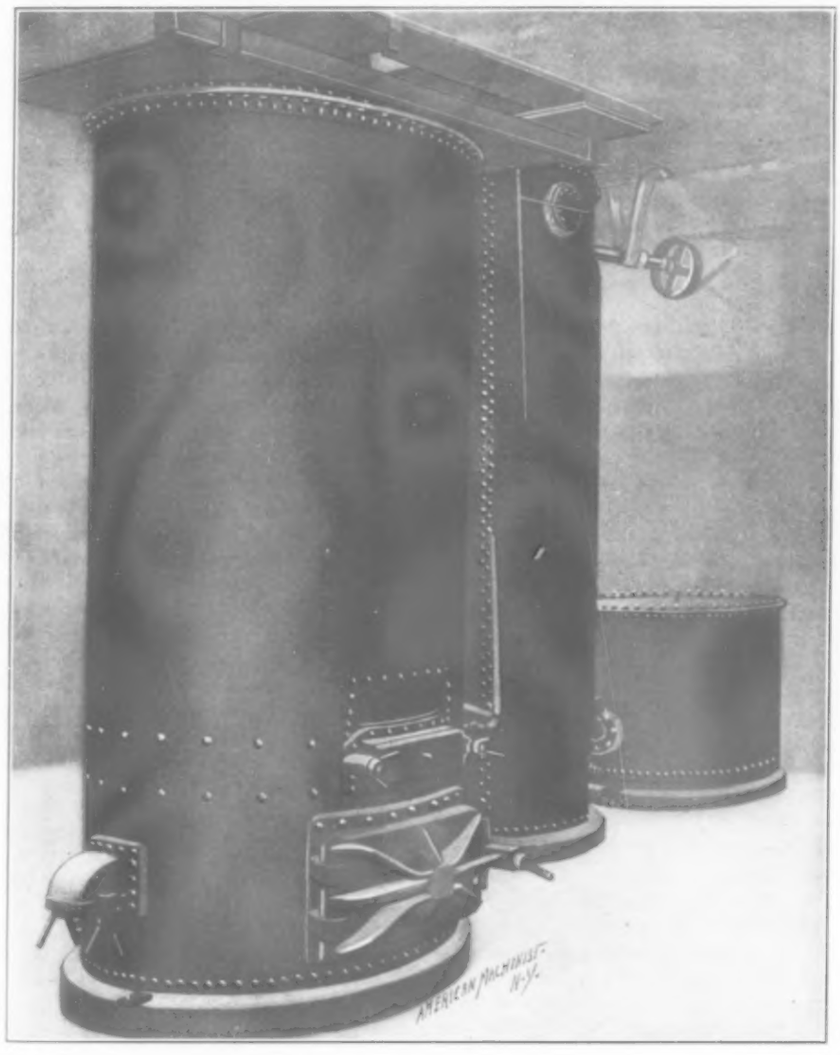


FIG. 1. THE PRODUCER, SCRUBBER AND PURIFIER

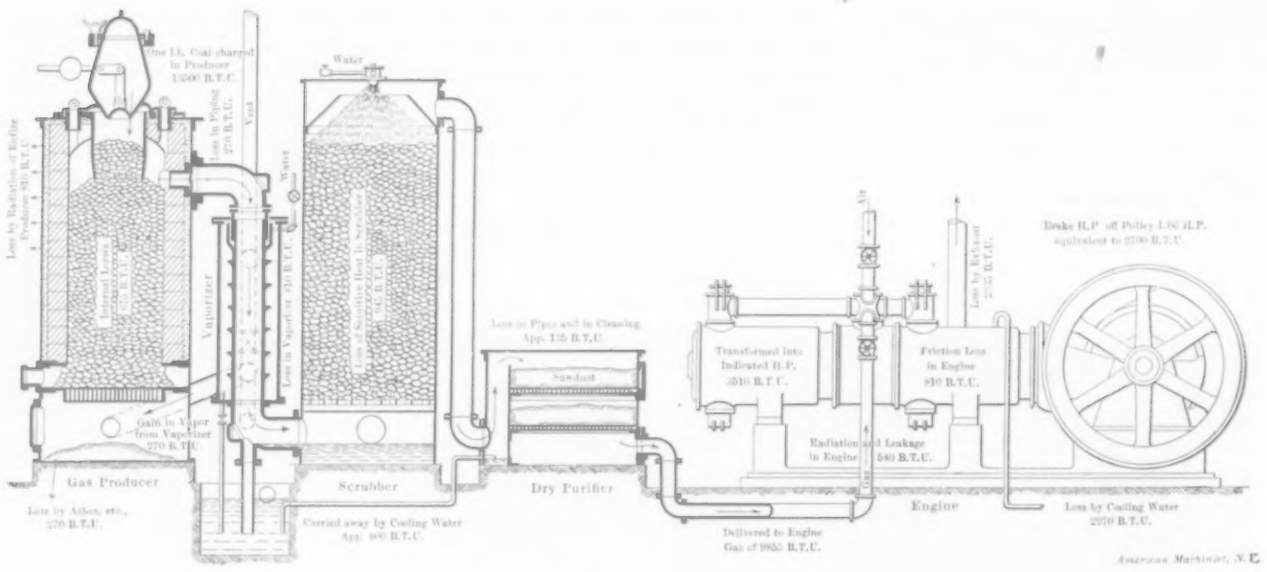

Water
Vapor
Vaporizer
Gas Producer
Scrubber
Dry Purifier
Sawdust
Engine
Gas in Vapor from Vaporizer 270 B.T.U.
Loss by Ashes, etc., 270 B.T.U.
Carried away by Cooling Water Abt. 800 B.T.U.
Loss in Pipes and in Cleaning Abt. 135 B.T.U.
Transformed into Indicated H.P. 3510 B.T.U.
Friction Loss in Engine 810 B.T.U.
Radiation and Leakage in Engine 540 B.T.U.
Loss by Exhaust 2755 B.T.U.
Brake H.P. off Pulley 1.66 H.P. equivalent to 2700 B.T.U.
Loss by Cooling Water 2970 B.T.U.
Delivered to Engine Gas of 9855 B.T.U.
American Machinist, N.Y.

FIG. 2. SUCTION GAS PRODUCER AND ENGINE

now is run with producer gas made from anthracite coal costing $4.50 per ton and which shows a saving, not very much per day, of course, in a plant of this size, but in a working year of 300 days it amounts to $120, the interest on $2000.

Fig. 1 shows the suction gas producer in the basement of the Philadelphia Gear Works. For the benefit of those who are not familiar with producers I show in Fig. 2 a sectional view of a gas producer of the suction type and for comparison I show at Fig. 3 a section of a steam plant with figures showing the power obtained from a pound of coal in each type of plant and also what becomes of the lost or wasted energy.

The producer externally looks very much like an ordinary boiler, is built of boiler plate riveted in the same way except that it does not have to stand internal pressure. Internally it is lined with fire brick and at the bottom is a grate under which is an ashpit. This ashpit is normally closed except for the pipe from the vaporizer which carries air heavily charged with moisture.

A fire is started on the grate of the producer and it is then charged from the top as shown with anthracite pea—or buckwheat—coal. The top is then closed. The moist air passing up through the fire and bed of coal carries with it the gas. This passes through a pipe which is led through the vaporizer, the heat from the gas converting a small trickle of water into vapor, which, as before stated, passes into the ashpit. From the vaporizer the gas passes to the scrubber, which is very similar in outward appearance to the producer. It is, however, not lined with fire brick but is filled as shown, with coke, the one in the Philadelphia Gear Works taking 29 bushels to fill it. Over the coke a continual spray of water is thrown by the sprinkler at the top. The object of the scrubber is to clean the gas, removing tar and other foreign substances, which cling to the coke, the gas passing on to the dry purifier. This is a cylindrical tank similar in construction to the scrubber but not so high. It is filled with sawdust and its office is to remove all moisture from the gas. In plants up to 150 horsepower the engine takes the gas direct from the purifier, but in larger plants a storage tank is used. The steam plant shown in Fig. 3 is familiar to all mechanics, so a description is unnecessary.

The operation of the plant is simplicity

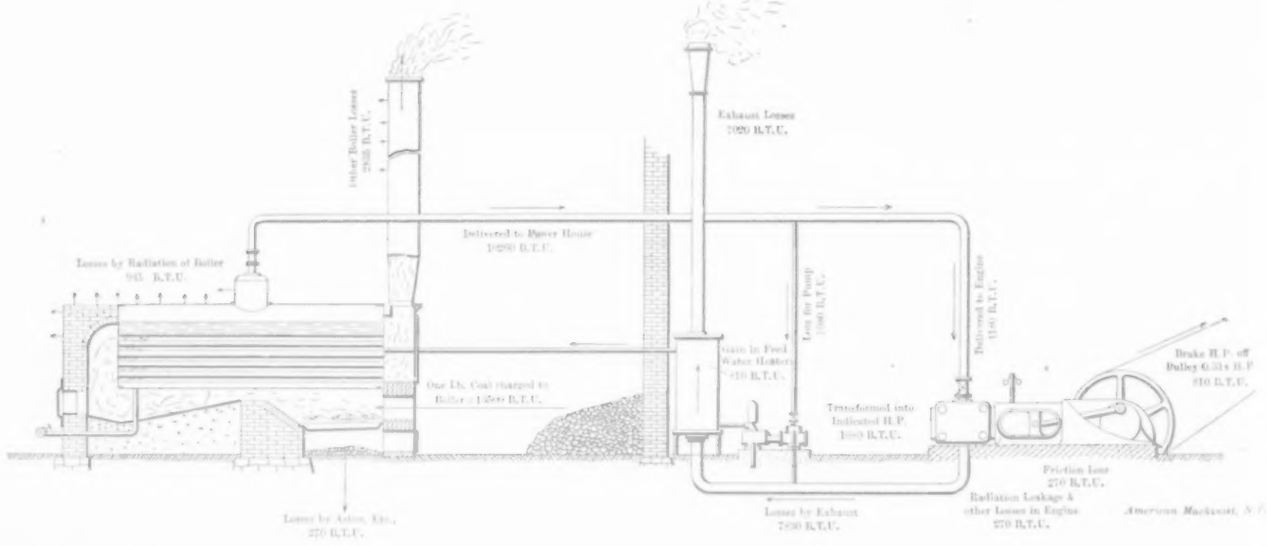

Exhaust Losses 7020 B.T.U.
Delivered to Power House 10980 B.T.U.
Losses by Radiation of Boiler 945 B.T.U.
Transformed into Indicated H.P. 1080 B.T.U.
Brake H.P. off Pulley 0.53 H.P. 810 B.T.U.
Friction Loss 270 B.T.U.
Losses by Exhaust 7020 B.T.U.
Radiation Leakage & other Losses in Engine 270 B.T.U.
Losses by Ashes, Etc., 270 B.T.U.
American Machinist, N.Y.

FIG. 3. STEAM PLANT

itself. The prefix *suction* reduced to its lowest terms signifies that the engine sucks its charge of gas from the producer by way of the scrubber and purifier.

Arranged on a board in the Philadelphia Gear Works is a set of three ordinary U-shaped gas gages filled with red ink so as to be readily readable. Another set of three similar gages is in the general manager's office, so that the operation of the plant is under his eye at all times.

One gage connects with the producer and under normal conditions shows about ¼-inch vacuum. The next is connected to the scrubber and shows about 1 inch vacuum. The third is connected to the engine and shows a vacuum of 1½ inches.

When starting in the morning the gas is tested by opening a small test cock on the scrubber and lighting the escaping gas. If a flame 4 or 5 inches long is the result then there is sufficient gas to start. The actual starting of the engine is done by admitting compressed air at 200 pounds into the cylinder. A belt-driven pump and storage tank for this purpose are located close to the engine.

Getting to Work after Commencement

By Entropy

About this time a few hundred commencement addresses to a few thousand technical graduates have begun to grow cold, and quite a few of the few thousands have begun to wonder if the world remembers that they are in existence and just where, if anywhere, they come in in doing the work of the world. They heard, or 90 per cent. of them did, commencement addresses from successful men of affairs, or successful ministers or successful professors; most of them were told how the speaker had become successful and were advised to follow in his steps.

When I read reports of the average canned, hermetically sealed, preserved-with-benzoate-of-soda commencement address I always think of the time when the little Entropies were beginning to need attention; my wife's folks loaded us up with good advice until I cut them off with, "I know all about the mistakes you made when you were bringing up children; now we are simply going to make a different set of mistakes." Just so, what a technical graduate wants to know is not what some ultra-successful man did to make money, but what blunders some of us common people made when we were trying to get on our feet. There is no danger that any of us were asked to make commencement addresses so we will have to hand it out as best we can.

Select Your Work Right

I want to say that the most important thing in a man's life is his work, and the most important thing about his work is that it should fit. Now I know a lot of men who have started out in life with dress-suit jobs, where a pair of overalls would have fitted much better. There are a lot of men who fit into a dress suit just right when they are working, but they do not usually stay through a technical course of education, and if they do it is "one" on the faculty.

The first thing a young man should do is to set down his list of good and bad qualities and then let some good, candid enemy revise them for him. I say bad qualities because he's got them unless he is so good that he will probably die young, in which case any kind of a job will do to tide him over.

Among his good qualities there should be some that will lead him into certain lines of work rather than into others. If he gets along particularly well with men it should influence him into different work than if he is peculiarly tactless. If he is especially good at mathematics he will do better in some lines than as if his special ability lies in the direction of finance. But the chances are that the process of elimination will leave him with a half a dozen lines that he can follow, if he wishes, with hopes of success. Within these limits he cannot decide and his friends are less competent than he is. There is or ought to be no special hurry for him to decide. Until a man marries it is unnecessary for him to settle down to a life job, and no man ought to marry until he has settled in his mind what he is going to stick to.

Thrift and Experience

A young man with no one to provide for but himself ought to lay aside a little money from the meanest job that any employer has the nerve to offer him. We have in this country a few employers who expect to hire technical graduates much below their real worth, holding out to them inducements in the form of hopes of future advancement. These very employers who make money out of raw graduates are the ones who will soonest ridicule the schools from which they come. It is the old story; familiarity breeds contempt, and since the boys will work for so little money to get what looks to them like good opportunities, the employers rate them accordingly. I believe that any young man can change employment several times before he is 30 to advantage. Changing too frequently is to be deplored. No matter if a certain job is distasteful there is much more to be learned about it in a year than in six months. Some employers will not let a man see the best side of a job nor their own best side for several months.

Successes and Failures of Others

Of all things do not let the successes or failures of your friends in any particular line influence you. Successes have been made in every possible line of human activity; failures do not need to be cataloged. Success depends more on the man than on the kind of a job. If one line of work pays better than it ought men will flock to it and competition will bring the price down. This is only temporary, however, for as soon as the price goes down men are scared away, and up it goes again. If a man is looking for steady work and is not easily scared by fluctuations then he will find that each rising tide will carry him a little farther on his way.

Almost any man will tell you that the way he made his success was by working night and day, by always being on the job. Now what he means is that he got into a line of work which he enjoyed so that it became a game, a pleasure to him. If a man can do that why should he not succeed? It sounds simple and is simple. To be sure, many a boy's father has spoiled a good doctor to make a fourth-rate engineer. The average American dislikes work; not work in general, but the particular work that he does to earn a living. Believing not at all in heredity, he throws away every possible chance that he has transmitted anything to his son that might make him valuable in his own line of effort and goes and makes a horse doctor of him. These boys whose right of choice of trades or professions has been denied them, are likely handicapped, but even they can profitably try more than one thing before settling down for life. Of course, none of this moving about will help the man who believes that the world owes him a living and who is trying to collect the bill. He will probably find that after so many generations of men have tried to get their living without work he might as well give it up and fall in love with an honest job.

When a man does find his place where he is really interested he begins to find that his hours of apparent labor decrease and his real attention to business increases until he is hard put to it to keep his mind off his work long enough for it to rest. Then his mind gets overtired, he cannot remember when he ever felt rested, and then he goes and delivers a commencement address on "How I worked when I was a boy."

Before the recent Congress on Applied Chemistry the advantages of oil fuel for use in connection with railway locomotives and ships were fully discussed, and as a result of experiments carried on by the British and United States navies, which were cited in the discussion and pointed out by an English contemporary, it was found that the evaporative efficiency of a pound of oil as compared with a pound of coal may be considered to be in the ratio of 17 to 10.

Experiments with Gases for Carbonizing*

Results Obtained with Illuminating Gas, Acetylene and Methane When Used Alone or in Combination with Ammonia Gas of Different Strengths

BY J. C. OLSEN AND J. S. WEISSENBACK

Owing to the close relationship between case-hardening and the hardening of steel, the following paragraphs are given from "The Hardening and Tempering of Steel," by F. Reiser:

"As the hardness of steel depends upon the form of its carbon, an explanation of the internal changes in the steel will deal with the change of one form of carbon into another.

"We usually distinguish four kinds of carbon in iron:

1. *Graphite*—When fused the iron holds all its carbon in solution. During solidification a segregation from the solution of carbon in iron takes place, in which the graphite separates out in the form of hexagonal plates, nearly uniformly distributed through the mass.

"This, however, only happens when the fused iron contains more carbon than it can retain in combination when cold; hence graphite never appears except in cast iron.

"2. *Annealing Carbon*—This results from a prolonged white heat and is so called because it usually makes its appearance in annealed iron. Like graphite, its form is not affected by quenching in water.

"3. *Carbide Carbon*—This form does not occur in a free state, but chemically combines with the iron. This compound is called carbide and its composition corresponds roughly to ferrite three atoms to each atom of carbon.

"Like graphite, carbide is the result of a segregating process, a separation on cooling from solution. The temperature at which this happens is about 1300 degrees Fahrenheit, and usually higher, the poorer the iron is in carbon. The formation of carbide, like that of graphite, and almost every other refining process, is accompanied by an evolution of heat, which can be seen by the eye in the dark. At the moment of formation of the carbon a recalescence of the steel is plainly visible.

"On heating the iron above the temperature above given, as that of the formation of the carbide, the carbon again enters into solution in the iron.

"4. *Hardening Carbon*—This forms with the iron in a completely uniform mass. When liquid, iron contains its carbon in this form only.

"By heating steels to the hardening temperature, which is at or near a dark cherry red, and according to the carbon percentage varies from 1450 to 1650 degrees Fahrenheit, all the carbon becomes hardening carbon. The more carbon there is the lower the hardening temperature must be taken. If the steel is now plunged in cold water, the carbon will remain in the hardening form due to its sudden cooling, and the steel will be hard.

"This extreme degree of hardness is generally called dead-hard or glass-hard. This does not, however, mean any definite degrees of hardness, and is simply used to distinguish the steel from untempered steel, and that which has been annealed, or from which the temper has been drawn.

"The hardening power of the steel increases with its percentage of carbon, and reaches a maximum at about 2 per cent.

"If the hardening temperature has been somewhat too high, its strength is diminished, it requires a crystalline structure and is overheated. If the steel is quenched when below a red heat, it becomes softer instead of harder."

Old Method of Case-hardening

Before taking up the new process of case-hardening by gas a few words concerning a research upon the older methods, that was conducted by G. Shaw Scott, of Birmingham, England, will not be entirely out of place. He says:

"The process known as case-hardening is one which consists of adding such a percentage of carbon to a relatively thin outside layer of iron and steel as will on correct quenching produce a hardened surface, while the inner core of the metal still retains its initial character."

In his research he brought out the following points:

1. That iron does not absorb carbon to any considerable extent below 1650 degrees Fahrenheit.

2. That the most rapid penetration took place when using a mixture consisting of barium carbonate and wood charcoal, while the least penetration resulted from the use of wood charcoal alone. However, when the heat was sufficiently prolonged the several mixtures gave approximately the same results.

In every case for the first four hours the carbon penetration was more than proportional to the time. After that there was a much less increase of penetration for a corresponding increase in time.

3. That the materials which give the most rapid case-hardening effect either contain nitrogen in some form or other, or else have the power of utilizing atmospheric nitrogen.

4. That free nitrogen has no effect upon steel, but that ammonia is absorbed by iron in the case-hardening process.

5. That bars after being heated with ammonia gas for four hours received a proportional increase of carbon penetration over unheated bars in the ratio of 45 to 32.

Demenge Method of Case-hardening

The Demenge method of case-hardening ingots consists in directly carbonizing one of the ingot faces at the time of casting by lining one of the vertical sides of the mold with carbonizing matter and preventing this carbonization from penetrating too deeply into the inside of the ingots by cooling the vertical side of the mold opposite to the carbonizing side.

Ingots cast in that way have been found to contain from 1.78 to 1.50 per cent. of carbon between their hard surface and a depth of 3.16 inches; from 0.60 to 0.40 per cent. of carbon between 1 and 2 inches from the surface; and from 0.35 to 0.15 per cent. of carbon between 3 9/16 and 4 inches from the surface.

Materials, Temperature and Grain

An article on "Case-hardening" which appeared in the *Iron Age* of October 5, 1899, gives the following facts:

1. The principal materials used in case-hardening are granulated raw bone, hydro-carbonated bone black, black oxide of manganese, sal soda, charcoal and salt. These materials are commonly used in railroad shops.

2. The case-hardening process takes about 12 hours. The articles are allowed to cool, when they are reheated and then cooled in cold water.

In another article in the same paper entitled "Case-hardening of Steel," by David Flather, the following points were advanced:

1. Carbonizers in general use are animal charcoal, bones and one or two other compositions consisting of mixtures of carbonaceous matter and certain cyanides or nitrates.

For very slight hardening, cyanides alone are still found very useful. Charred leather gives the most certain and satisfactory results.

2. Proper hardening heat for case-hardening is 1800 degrees Fahrenheit.

3. All case-hardened articles must be reheated to 1475 degrees Fahrenheit and then quenched until quite cold in water. The steel must always be quenched on a rising temperature.

*Abstract of paper read before the American Institute of Chemical Engineers at its Brooklyn meeting.

4. When extreme hardness is the first consideration the hardening heat may be raised to 2250 degrees Fahrenheit. In this operation the articles are cooled to a red heat and then quenched direct from the furnace. They are then reheated to full cherry and again quenched.

5. Perfectly case-hardened steel when fractured will show a case of fine white grain, which is clearly defined and of a very regular depth. The core is finely granular and of a distinctly metallic luster.

6. If the case is full of minute brilliant specks, it is not so clearly defined, and if the core is much coarser and more sparkling, it shows that the article was quenched direct from the furnace, or if heated a second time, it was not raised to a temperature sufficiently high to re-arrange the structure caused by the high temperature of case-hardening.

7. If the outer zones of the case are coarser as in 6, while the remainder and also the core are a very little coarser than 5, the reheating temperature was too high.

8. If the case appears as in 6, the core is gray and fibrous, or when broken laterally, shows marked lamination, the heating was too long and too high before quenching.

9. Phosphorus and sulphur should not be added to the steel when carbonizing, as too much phosphorus causes brittleness and sulphur renders the steel difficult to work while hot.

Points on Case-hardening with Gas

In the AMERICAN MACHINIST on page 263 of Part 1 of Vol. 31, the article, "Case Hardening Steel with Gas," by E. F. Lake brings out the following points:

1. Carbonizing materials are of three classes; (a) those which act by means of carbonic oxide, (b) those which act by means of a cyanide, (c) those which act by means of the hydrocarbons.

2. The best steels for carbonizing are not those that give the best results for annealing, hardening and tempering. It is, therefore, apparent that the best carbonizing steel is the one that contains the least amount of carbon.

3. Manganese has a tendency to render the carbonizing surface brittle. The manganese should never exceed 35 per cent.

4. A longer time is required to carbonize with solid materials than with gases.

5. The distinct line between the case and the core is obtained by plunging the metals directly from the furnace into a quenching bath.

6. As a general rule all pieces should be annealed after being carbonized, in order to destroy any crystallization in the core. This is accomplished by heating the metal a little above the point of transformation, which is about 1625 degrees Fahrenheit, and then cooled slowly. This, however, leaves the carbonized surface too soft to resist wear, so the work is again heated to about 1400 degrees Fahrenheit and then quenched.

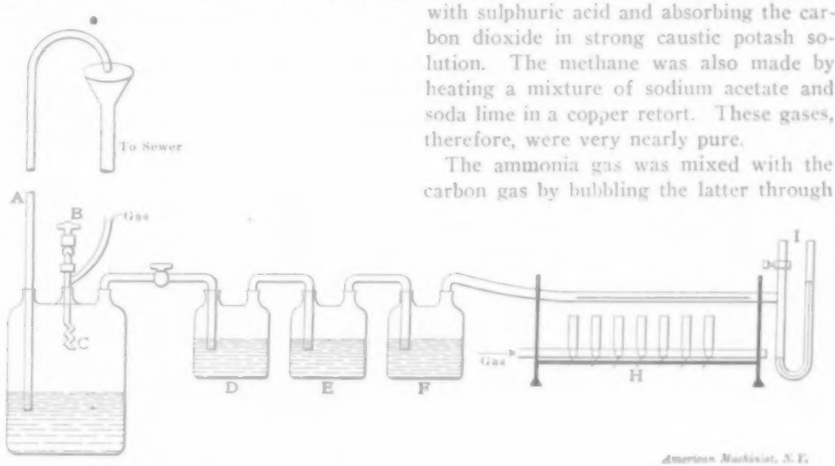
7. As a general rule steels cannot be raised above 1600 degrees Fahrenheit without becoming liable to crystallization. The higher the temperature, the deeper and more rapid the carbon penetration.

8. The carbon begins to penetrate the steel at about 1300 degrees Fahrenheit. The temperature for ordinary steel should never be raised above 1700 degrees Fahrenheit.

Carbon Absorption

The charred organic material that was usually used in the older method, such as wood charcoal or burnt leather is invariably alkaline from the decomposition of the alkaline salts originally present in the vegetable fiber. The leather was particularly advantageous because of its high nitrogen content. Potassium cyanide has also been used as this salt contains the alkali carbon and nitrogen.

As a result of heating iron in contact with material of this kind the iron absorbs more or less carbon, depending upon the temperature to which the mixture was heated, the materials present, and the length of the time of heating. Investigation has shown that the absorption of carbon is much more rapid from material containing nitrogen, and further that this nitrogen must be in combination; free nitrogen having no influence on the process.



APPARATUS USED IN EXPERIMENTING WITH GASES FOR CARBONIZING MATERIALS

As no published records were available to ascertain the relative efficiency of the various carbon gases for carbonizing steel, an investigation was undertaken to study this question at the Polytechnic Institute and also to ascertain what chemical reactions take place when the carbon from a given gas enters the steel.

It was ascertained that if the case-hardening is carried out with gases subjected to a certain amount of pressure the action is much more rapid. This was to be expected, inasmuch as the carbonaceous material is in this manner concentrated in the vicinity of the surface of the steel, that being the only place where action can take place.

Gases Used

In these experiments the following gases were used: Illuminating gas, as supplied in Brooklyn by the gas company; methane, carbon monoxide and acetylene. These gases were tried alone and also in combination with ammonia gas of three different strengths.

The illuminating gas of Brooklyn contains on the average about 26 per cent. of carbon monoxide, the same per cent. of hydrogen and methane, about 12 per cent. of illuminant, consisting of ethylene, acetylene and benzine, and small proportions of free nitrogen, oxygen, carbon dioxide, etc.

The acetylene gas was taken from a presto-lite tank, which was the same as that used in automobiles for lighting purposes. As 98.5 per cent. of the gas was absorbed by bromine, it was considered sufficiently pure for carbonizing purposes.

The carbon monoxide was made in the laboratory by decomposing oxalic acid with sulphuric acid and absorbing the carbon dioxide in strong caustic potash solution. The methane was also made by heating a mixture of sodium acetate and soda lime in a copper retort. These gases, therefore, were very nearly pure.

The ammonia gas was mixed with the carbon gas by bubbling the latter through Wolff bottles containing an aqueous ammonia of definite strength. The amount of ammonia introduced into the gas was ascertained by allowing a liter to pass through a definite amount of standard sulphuric acid and titrating back the excess of acid with standard alkali. The per cent. of ammonia gas was then calculated.

Stengths of Ammonia

Three strengths of ammonia were used as follows: (a) 125 parts of 28.5 per cent. ammonia with 875 parts of water; (b), 250 parts of the strong ammonia, with 750 parts of water, giving (b) double the strength of (a); (c) 500 parts of strong ammonia and 500 parts of water, giving (c) twice the strength of (b) and four times the strength of (a). Aqueous ammonia seemed to be the best form in which to introduce the nitrogen into the case-hardening gas.

It was found that when gas was bubbled through the weakest ammonia (a) it con-

tained 2.28 per cent. of ammonia gas. When bubbled through (b) it contained 4.80 per cent., while with (c) 11.40 per cent. of ammonia gas was found in the resulting mixture.

Method of Conducting Experiments

Experiments were first carried out with illuminating gas to ascertain if the ammonia would combine with the carbon monoxide, or other carbon gas present, to form cyanides or cyanogen. For this purpose the mixture of ammonia and illuminating gas was passed through a glass tube, which was heated in a combustion furnace to the case-hardening temperature, namely 1475 deg. F. The temperature was measured by means of No. 17 Seger cones and pieces of potassium and sodium chloride. The sodium chloride melts at 1480 degrees and the potassium chloride at 1442 degrees Fahrenheit.

The apparatus with which these experiments were carried on is shown in the accompanying line cut.

The illuminating gas, carbon monoxide, methane and acetylene were sucked into the large Wolff bottle at *B* and there given a pressure of four pounds per square inch by the column of water at *A*. This pressure was regulated by the pinch cock in the mercury pressure gage at *I*. From the large Wolff bottle *C* the gas under pressure was bubbled to the small Wolff bottles *D*, *E* and *F*, which contained the aqueous ammonia. The mixed gas is then sent into the American Gas Company's carbonizing furnace, located at *H*, which was loaned by the company for these experiments.

Analyzing for Carbon

The actual case-hardening experiments were carried out on samples of soft Norwegian iron, containing only 0.08 per cent. of carbon. This iron was purchased in rods ⅜ inch in diameter and was cut up into six-inch lengths. A common gas pipe was used to case-harden these pieces in, and this was placed in the furnace *H*, which was maintained at a temperature of 1500 deg. F. After the proper time had been given for the carbon penetration, the samples were heated to the proper temperature and quenched in cold water or oil.

The samples for analysis were obtained by turning off the outer layer upon the rods that were carbonized in a lathe. On many of the samples this was impossible but on drawing the temper it was found a simple matter to obtain samples.

The per cent. of carbon in the iron, both before and after case-hardening, was determined by dissolving the iron in cupric potassium chloride and oxidizing the remaining undissolved carbon by means of chromic anhydride and sulphuric acid, then absorbing the resulting carbon dioxide in caustic potash and weighing.

The depth to which the carbon penetrated was obtained by breaking the rod and measuring the hard case by means of a microscope fitted with an occular micrometer. The results of these various experiments are shown in the accompanying table.

Conclusions

It is evident that ammonia gas facilitates the case-hardening in all cases except that of carbon monoxide, which seems to act almost as well without as with ammonia. Of the three pure gases studied, the carbonizing ability is in the following order: Carbon monoxide, acetylene, methane. The illuminating gas not being a pure gas and varying in composition with the different gas companies, it cannot be given a fair comparison with the other gases.

With illuminating gas and the strongest ammonia the four-hour test showed a very good percentage of carbon, and in the eight-hour test the percentages of carbon ran about equal in all of the three different strengths of ammonia.

The results obtained from carbon monoxide show it to be by far the best gas for this purpose, and the difference in the carbon percentage between carbon monoxide alone and carbon monoxide combined with the strongest ammonia was so slight that it does not seem necessary to use ammonia with it.

In the case of carbon monoxide the gas was freed from carbon dioxide by bubbling through strong caustic potash solution before entering the case-hardening tube. Roughly speaking, the hardening depth is for the four hours proportional to the time.

Test Number.	Gas Used.	Time in Hours.	Hardness.	Depth of Case, Inches.	Carbon Content, Per Cent.
1	Illuminating and ammonia(*a*)	4	glass	0.004	0.57
2	Illuminating and ammonia(*b*)	4	glass	0.008	0.66
3	Illuminating and ammonia(*c*)	4	glass	0.008	0.91
4	Illuminating	4	none	none	none
5	Illuminating and ammonia(*a*)	8	glass	0.012	1.12
6	Illuminating and ammonia(*b*)	8	glass	0.012	1.16
7	Illuminating and ammonia(*c*)	8	glass	0.012	1.15
8	Carbon monoxide and ammonia(*c*)	4	glass	0.016	1.45
9	Carbon monoxide	4	glass	0.016	1.36
10	Acetylene and ammonia(*c*)	4	glass	0.012	0.98
11	Acetylene	4	little	not well defined	0.41
12	Methane and ammonia(*c*)	4	little	not well defined	0.32
13	Methane	4	little	not well defined	0.26

RESULT OF EXPERIMENT OF CARBONIZING STEEL WITH GASES.

A Double-rate Premium Plan

By H. F. MacLane

One of the most important questions before the world today is the harmonizing of capital and labor. The truth of this statement is borne out not only by the rapid strides that socialism has been making these last few years, but by the recognized fact that this subject is receiving more profound study than ever before by manufacturers, by students of political economy and by those politicians who have their ears to the ground; and while there has been considerable advancement in this matter during the past decade, there is much further progress to be made before we will have come very near to reaching the millenium.

Probably the most prominent feature of this subject is the wage question. Each advance that has thus far been made in the wage systems has ironed out some of the existing defects, but many faults still remain to be eradicated before an entirely equitable adjustment of the relations of employer and employee will be effected. While the day-work system, the oldest plan, is perhaps still the logical system under which certain classes of labor should be paid, the introduction of piece work, with its incentive toward increased production, was undoubtedly a very big step in the right direction; and it is equally true that, in its turn, the premium system has many advantages over either of the other two plans.

In consequence of these advancements in the method of paying wages a pleasanter feeling exists between the capitalist and the workingman; and the clouds that for the past half century have been gathering have been, with some notable exceptions, fairly well held in check. However, due to the fact that neither the piece-work nor the premium plan, although undeniably accomplishing much, has given us an approach to a perfect system, these clouds still exist and grave disturbances in our social system will result unless either the present wage systems are greatly improved, or a new and very much better system devised for the apportionment of compensation that will be perfectly fair both to the employer and the employee. It is, therefore, the duty of everybody whom experience or environment has fitted for the purpose to give to this subject deep study toward a logical analysis and proper solution of the question.

The Day-work Plan

The day-work plan of paying a set rate per day or hour, regardless of the amount of work the different workmen could or did perform, was certainly unfair to the better class of workmen and offered them no incentive for doing more than merely sufficient work to insure the holding of their jobs, which naturally would be equal

to the amount performed by their slower fellows. This state of affairs is equally unsatisfactory to the employers; and by the same token the day-work plan is the most expensive method of payment as far as the cost per piece is concerned. A natural result of this herding of men into classes, paying all of each class the same wages and offering none of them any inducements to work harder or to do better work than the average was for the men to organize.

The Piece-work System

The immediate and greatly increased production that followed the introduction of the piece-work system not only surprised the employers but served to show them the excessive costs per piece they had been paying under the day-work plan, as well as to what a capable extent their employees had been "soldiering." In many cases the workmen themselves were surprised at the increased output of which they found they were capable, and the corresponding fattening of their pay envelops spurred them on to increased efforts. This big increase in the pay roll, together with the irritating knowledge of the manner in which the workmen had "laid down" in the past, resulted in sweeping cuts in the original piece-work prices. The further cuts, restricted output and strikes that followed are so well known to every employer and every workman that it is not necessary to make any portion of their history a part of this article. It is sufficient to say that the piece-work system proved to be far from the unadulterated blessing that was expected; and it will be surprising only to those who have had no experience in a business involving wage earners paid by the piece to learn that such workers, instead of availing themselves of their opportunities to increase their earnings, systematically hold them down to a certain limit, or, in other words, restrict production.

The Premium Plan

The premium plan was next offered as a solution of the wage difficulties, and it is believed by many, including the writer, to have gone a long way toward accomplishing this purpose. Under this system the profit made by the workmen in addition to their regular wages is shared by them and the company, their hourly rate being automatically increased in proportion to the amount of work performed, while the cost to the company is correspondingly decreased. In addition to this the company's overhead charge is also decreased, the increased output per man necessitating a less number of workmen and, therefore, less supervision and less clerical expense, and the increased output of each machine making necessary a less number of machines and consequently less floor space. In consideration of these advantages the employer guarantees to make no cuts in the time limits originally set, unless some radically simpler or improved method is devised for doing the work, it being understood that the only procedure by which he can reduce the price is by placing lower rated men on the work.

The premium plan has to a large extent overcome the chief difficulties of the piece-work system whereby, on the one hand, the workmen derived practically all the profit, and on the other the prices were frequently cut, but it has not reached perfection in this latter respect. The recollection of their experience with the piece-work system is so distinct that the workmen are often inclined to accept with considerable doubt the assurance that time limits when once set will not be cut, and it is very frequently the case that it is not possible to convince them that these promises are sincere. They do not appreciate the fact that the time limits are now being set by scientific methods and that correct and perhaps lower limits will be placed upon new work regardless of the speed at which any similar jobs have been turned out. This feeling often results in much the same practice as with the piece-work plan and, instead of turning out their maximum possible output, the workmen will restrict the production to a certain amount.

An Element of Failure in the Premium Plan

As an example, we will say a concern agrees to divide equally with the workmen all the time they save while working on a limit, in which case if a workman completes in 10 hours a job that has a limit of 30 hours he will have saved 20 hours and, under the above agreement will be paid for half of this gain or 10 hours in addition to the 10 hours put in on the job, thereby doubling his rate per hour. If however, the workman feels that by doing this job in the shortest time possible he will influence the company to reduce the time limit from 30 to 20 hours on future jobs of this kind, he will very likely put in 15 hours on the job instead of 10, in which case he will save 15 hours and will be paid for half of this time; this will result in bringing his rate up to only 50 per cent. more than his regular day rate, and at the same time will, of course, increase the cost of the job to the company.

As this condition undeniably exists in many factories that have adopted the premium system, various plans are at present being tried out in an effort to break up this practice of restricting production on the part of the workmen; every uptodate manufacturer being thoroughly awake to the present necessity for reducing his costs in order to meet the competition that now exists and which is steadily becoming more pronounced. The object of this article is to describe a plan of this kind which seems to be practicable and to possess advantages which recommend it to both the manufacturer and the workingman.

The Proposed Double-rate Premium Plan

In almost any shop it is true that workmen on the same class of work are paid a variety of different day rates, due to a number of causes. In some cases the rate of an old employee has been increased from time to time until he is being paid a much higher rate than the man working next to him on the same class of work and who perhaps is doing much better work; in another case the increased rate may be the result of a "pull" with the foreman. In short, for insufficient reasons the highest rated men in the department may be and often are the poorest workmen.

This manifestly unfair arrangement tends to discourage the better workmen and there is little incentive for them to produce their maximum output, especially in view of their already formed prejudice against doing so. The following plan, which may properly be termed an additional incentive to the premium system, should remedy this condition of affairs, both insofar as the incorrect basis on which the workmen's rates are in many instances set and as an inducement for the men to produce their maximum possible output.

Instead of having the present variety of day work or hourly rates, which in many cases average abnormally high, due, as suggested above, to increases being granted old employees from time to time, two fixed rates should be set for each different class of work, a high rate of say 30 cents and a low rate of 25 cents per hour; this high rate to be about the average high rate at present paid and the low rate to be sufficiently lower than the present average rate of the department that it would be looked upon as a penalty. All the workmen on the same class of work in the department would be started at the lower rate, and all new men hired for this work would be hired at this figure. Having in mind a factory where the amount of time saved is shared equally between the workmen and the company and where the sentiment of the workmen would be to do no better than time-and-a-half, that is to increase their rates no more than 50 per cent. (a different basis could be used where a different division is made of the time saved), a proposition should be then made to the men that all those averaging time-and-three-quarters, that is those making 175 per cent. of their day rate, for the entire month would be rated during the following month at the higher rate for that class of work; their rates to remain at this higher figure as long as they continue to keep their earnings or output up to or above the required average, and to be reduced to the lower figure for any month following one during which they would fall under this average.

An Example Illustrating the Workings of the Double-rate Premium Plan

The following example shows the time record of a workman who earned 177 2/9 per cent. of his regular day rate during the first month and who is therefore entitled to the increased rate for the next month. The "Hours Gained" are the total hours saved on his time limits, half of which gain represents the "Premium Hours" for which he is to be paid. This example shows the man working on jobs that last several days; but the time record for a man working on several jobs each day would be made up in exactly the same way, it merely requiring more entries. The pay roll of the department is made up of a summary taken from these time records of the different workmen.

NAME J. J. SMITH — CHECK NO. 72
DEPT. A — RATE 25c.

Order No.	Date.	Hours Taken.	Hours Gained.	Amount Payable.
12472	1-3-4-5-6-7	55	90	$25.00
10913	8-10-11-12	35	70	17.50
12717	13-14-15-17	35	50	15.00
15432	18-19-20	30	50	13.75
14721	21-22-24-25	35	40	13.75
12076	26-27-28-29	35	50	15.00
Totals		225	350	$100.00

REGULAR HOURS	225@.25	$56.25
PREMIUM HOURS	175@.25	43.75
TOTAL HOURS	400@.25	100.00

PERCENTAGE OF TOTAL HOURS EARNED TO REGULAR HOURS WORKED, 177⅞%.

RATE FOR JUNE 30c.

SPECIMEN WORKMAN'S TIME RECORD.

The application of this plan as it has been outlined would permit the time slips to be figured to show money values and these values could be placed on the time record each day as the slips are posted. The charges to the different orders worked on during the month could then be quickly obtained by sorting the time slips to order numbers and taking off a total for each order.

An objection to the plan as described might be that the rate as determined by the number of hours gained during the month should be applicable for the month on which this rate is based rather than for the succeeding month. In this event the only change necessary in the plan as outlined would be that the time slips would be posted daily to the time records to show only the hours worked and the hours gained, these two columns to be totaled at the close of the month and the rate at which the hours posted should be entered to money values to be determined by the percentage that the total hours gained would be of the total hours worked. The time slips could be figured to show the money values after the rate had been determined, and the distribution to orders could then be made by sorting the slips to order numbers as has already been described; or this distribution might be made from the postings on the monthly time record, in which event the extensions on the time slips need not be made.

Aside from the fact that there might be delay in making the distribution to orders, better results perhaps would be obtained by operating this plan so that the rate each month would depend upon the relation of the total hours gained to the total hours worked during that particular month rather than upon these figures for the preceding month. In either case, however, the principle of the plan and the result at which it aims remain the same, and the most suitable application of the plan would depend upon local conditions.

Advantages to Both Employer and Employee of the Double-rate Plan

The adoption of this plan should result in the workmen producing their maximum possible output and therefore reducing the cost to the company, as no workman would voluntarily reduce his hourly rate five cents no matter what effect his increased earnings might have on the time limit, especially as he would have every reason to believe that other workmen in his department were turning out the work in the reduced time and were being paid the higher rate, even if they should claim this were not the case. If every man in the department should succeed in earning the higher rate and the pay roll should be correspondingly increased, the company would still be an even greater beneficiary than the workmen, receiving an increased output per man and for each machine with no increased supervision and at a considerably reduced cost per piece. What more could be asked either by the company or the workmen? As the workmen would have laid aside their idea of a restricted production they probably would earn a much higher average, if possible, than that required; to off-set some jobs on which they would realize they had fallen under the stipulated average it would be necessary for them to make especially good time on some other work.

Under this plan each man's rate would be controlled by the pay roll, and the higher rate could be obtained only by efficient work; no low grade workman could be rated too high, and the management would be furnished an excellent opportunity for determining who were the inferior workmen and weeding them out. No favors could be shown by the foreman as is now very often done; and one of the valuable features of the plan is that there would be no more requests for increases in rates, as the men would know that their rates would depend altogether upon themselves. The foreman's burden would be lessened not only on this latter account, but as each workman would have sufficient reasons of his own for keeping busy and doing his work properly (no premium being paid for defective work) the foreman should experience very little difficulty in properly supervising his department.

At times when the work would be slack instead of killing time on a job so as to put in the entire day as is often done, the workman would not care to risk lowering his premium and thereby reducing his hourly rate but would advise his foreman that the job was completed and that if there were nothing else to do he was ready to go home.

File Teeth

By Walter Gribben

The articles by Mr. Herbert on the results obtained with the file-testing machine have been extremely interesting, and one point he mentions at page 932, Vol. 32, Part 1, has engaged my attention for several years, although I have not had the opportunity to investigate it as thoroughly as the subject seems to deserve. He refers to the pitch of the up-cut and over-cut being different. Of course, as Mr. Herbert points out, a certain amount of difference is a necessary and valuable feature in any file, but if the difference is too small in amount it makes the rows of teeth at such a slight angle with the axis of the file, that when driven by hand, as in ordinary use, the motion of the file tends to follow the rows of teeth instead of its own axial line, and this is particularly the case with a new machine-cut file. Under the conditions named, it is almost impossible for even a skilful filer to push the file in a line parallel to its own length, as it has a strong tendency to drift to one side and leave grooves and ridges in the work. This defect would not be made apparent in the file-testing machine, as there the file is held rigidly, and has to travel in a prescribed track, as far as any side motion is concerned.

As to the minimum angle allowable between the rows of teeth and the axis of the file, that is a question that might possibly bear fruit in the shape of useful information if investigated by someone so placed as to have access to new files of many different kinds and makes. As a guess, I should say about 20 degrees, or possibly 15. Mr. Herbert states that if the up-cut and over-cut are of the same pitch, the rows of teeth will be parallel to the axis of the file, and I should like to add that this will be true regardless of the slope of either cut. But when the pitch is not the same for both cuts, then the shape of each cut has a slight influence on the direction of the rows of teeth, but not to the same extent as is caused by the pitch being different for the two cuts.

Jonathan Hulls and His Steamboat

Sketch of the Inventor and Description of One of the Earliest Patented Systems of Vessel Propulsion by Means of the Steam Engine

BY EDWARD P. BUFFET

If the great-great-great-grandfather of any AMERICAN MACHINIST reader chanced to spend his boyhood at the village of Campden, in Gloucestershire, England, about 170 years ago, he must often have seen plodding along the roads a poorly clad but intelligent-faced clock tinker carrying his box of tools as he went from house to house to seek those little jobs which totaled the means for only a scanty subsistence. It might have been noticed that this man had a more earnest and far-away look in his eyes than is usual for the country mechanic, that he seemed ever to be inwardly wrestling with deep problems, and that he wore the expression of a man who has failed in some great ambition of life, yet who has not broken off, and never could break off, the habit of performing ambitious labors in his head. Shy and diffident in his manner, he would gladly have shunned the sight of passers-by, and well he might, for youths of wanton disposition were relentlessly pursuing him with the refrain:

"Jonathan Hulls, with his paper sculls, invented a machine to go against the stream; but he, being an ass, could not bring it to pass, and so he was ashamed to be seen."

We have recognized in this portrait of Jonathan Hulls the typical unsuccessful inventor. If you are bound to be an unsuccessful inventor and value your peace of mind by all means be one in some large city, and not in the country among your friends and neighbors.

Jonathan Hulls was born, it is said, at Hanging-Aston, near Campden, in 1699, but his father, Thomas Hull, or Hulls, removed to the latter place and there the boy received his academic training in an ancient grammar school. A man's real education, however, is that which he gives himself by outside study, or, best of all, by interested reading, for it is chiefly what interests us that we remember and that does us good. It is probable that if Jonathan's education had been limited to his perfunctory lessons at school he would have remained through life half illiterate like the other boys of his class; but he had a natural bent for mathematics and in some way made himself fairly proficient in the principles of mechanics. He was also able to write in a decent English style.

The trade of "clockmaker" which he took up was in reality that of an itinerant clock mender. He was accustomed to make a circuit through a certain district curing the ailments of any farmhouse or church timepieces that chanced to be under the weather. Hulls married early and removed to the hamlet of Broad Campden about 1729. His studious habits and mental ability, far superior to that of his neighbors, readily won him a local reputation for intelligence. That particular work of genius which has earned him belated fame in the world is said to have seethed in his imagination from his youthful years. To realize so ambitious a project as a steamboat, either in the water or in print, was an audacious attempt for a country clocksmith of those days, with a family to support. He therefore did what aspiring authors of his time were accustomed to do and sought the aid of a patron. This was a Mr. Freeman, of Batsford park, near Aston, who was so much impressed with Hulls' invention that he put up the money for a trip to London to embody it in a patent and a pamphlet.

That monograph appeared in 1737. Its publication was the high-water mark of Hulls' success, for there is no record that anyone ever took enough notice of the work to build a steamboat on the lines suggested. Mr. Freeman was reasonably loath to support any additional venture for exploiting the invention, and Jonathan was abandoned to his fate of failure and ridicule.

For a long time no more is heard of him, but a real inventor, especially an unsuccessful inventor, is insuppressible though he live a thousand years, and the bee of ambition continued to buzz in Hulls' bonnet. Eventually he cropped out in print with new products of his brain.

His final known attempt was in 1754, when, in partnership with two fellow-townsmen, R. Darby and William Bradford, schoolmaster, he had patented a "Statistical and Hydrostatical Balance" and a "Sliding Rule for Artificers." The former was "an instrument for detecting frauds by counterfeit gold, which gives the weight and shews the alloy of that metal in coin and all untensils made thereof, and if adulterated, the nature and extent of the alloy." This instrument displayed much ingenuity and at least one actual specimen of it has survived to our day. The sliding rule, which probably was not a logarithmic slide rule, is described in a pamphlet entitled: "The new Art of Measuring made easy by the help of a new Sliding Rule. Coventry: Printed by T. Brooks in Broadgate, 1754."

Little or no financial return was destined to attend any of Jonathan Hulls' efforts and, finally, unable to meet the gaze of his neighbors, he hid himself in the London crowds. At a date which is unknown, he died the death of an inventor.

Down to comparatively recent times his descendants have remained in his own village, mechanics, like himself, and with his modesty if not with his genius. The widow of their last survivor in the district died in 1865, not long after which the family cottage at Broad Campden in which Jonathan Hulls had dwelt, was torn down.

It would be too much to claim for Jonathan Hulls that he was the first man who ever designed a steamboat. The idea seems to have been a favorite one for inventors in the first part of the eighteenth century. Neither can he receive the credit which attaches to one who has made the invention commercially practical. But assuredly he deserves always to be remembered as one of the most important forerunners of steam navigation. There is no telling what would have resulted from his efforts could he have secured the pecuniary coöperation of a Boulton or a Livingston.

Of the book published in 1737 by Jonathan Hulls, a few copies are still extant and from one of them, or rather from a fac-simile, extracts are here reproduced.

It will be noticed that Hulls did not invent a marine engine, but merely the application of power from a Newcomen engine to propel a towboat. (See illustration.) Most of this 48-page pamphlet is taken up with demonstrating mechanical and hydrostatic principles involved in his mechanism. Like Euclid, he seems to take nothing for granted, but to develop, step by step, even the simpler and more obvious propositions in this theory. This part of the work shows that he had put himself through a pretty good mathematical training.

But let Mr. Hulls tell his own story:

EXTRACT FROM JONATHAN HULLS' PAMPHLET

In some convenient part of the Tow-Boat, there is placed a Vessel about two 3ds full of Water, with the Top close shut, this Vessel being kept Boiling, rarifies the Water into a Steam, this Steam being convey'd thro' a large Pipe into cylindrical Vessel, and there condens'd, makes a Vacuum, which causes the weight of the Atmosphere to press on this Vessel, and so presses down a Piston that is fitted into this Cylindrical Vessel in the same manner as in Mr. *Newcomens* Engine,

with which he raises Water by Fire. *See fig.* 30.

P. The Pipe coming from the Furnace to the Cylinder.

Q. the Cylinder wherein the Steam is condensed.

R. the Valve that stops the Steam from coming into the Cylinder, whilst the Steam within the same is condensed.

S. the Pipe to convey the condensing Water into the Cylinder.

T. a Cock to let in the condensing Water when the Cylinder is full of Steam and the Valve *P* is shut.

U. a rope fixed to the Piston that slides up and down the Cylinder. *Note*. This Rope *U* is the same Rope that goes round the Wheel *D* in the Machine.

It hath been already demonstrated, that a Vessel of 30 Inches Diameter, which is but two Foot and a Half, when the Air is driven out, the Atmosphere will press on it to the Weight of 4 Ton 16 Hundred and upwards, when proper Instruments for this Work are applied to it, it must drive a Vessel with a great force.

Note. The Bigness of the Machines may be proportioned to the Work that is to be performed by them; but if such a force as is apply'd in this first Essay be not sufficient for any Purpose that may be required, there is room to make such Addition as will move an immense Weight with tolerable Swiftness.

In my Opinion, it will not be found Practicable to place the Machine here recommended, in the Vessel itself that is to be taken in or out of the Port, *&c*. But rather in a separate Vessel, for these Reasons:

1. This Machine may be thought Cumbersome, and to take up too much Room in a Vessel laden with Goods, Provisions, *&c*.

2. If this Machine is put in a separate Vessel, this Vessel may lye at any Port, *&c*. to be ready on all Occasions.

3. A Vessel of a small Burthen will be sufficient to carry the Machine to take out a large One.

4. A Vessel will serve for this Purpose for many Years, after she is thrown off and is not safe to be taken far Abroad.

THE EXPLANATION OF THE MACHINE

A, Represents the Chimney coming from the Furnace.

B, The Tow-Boat.

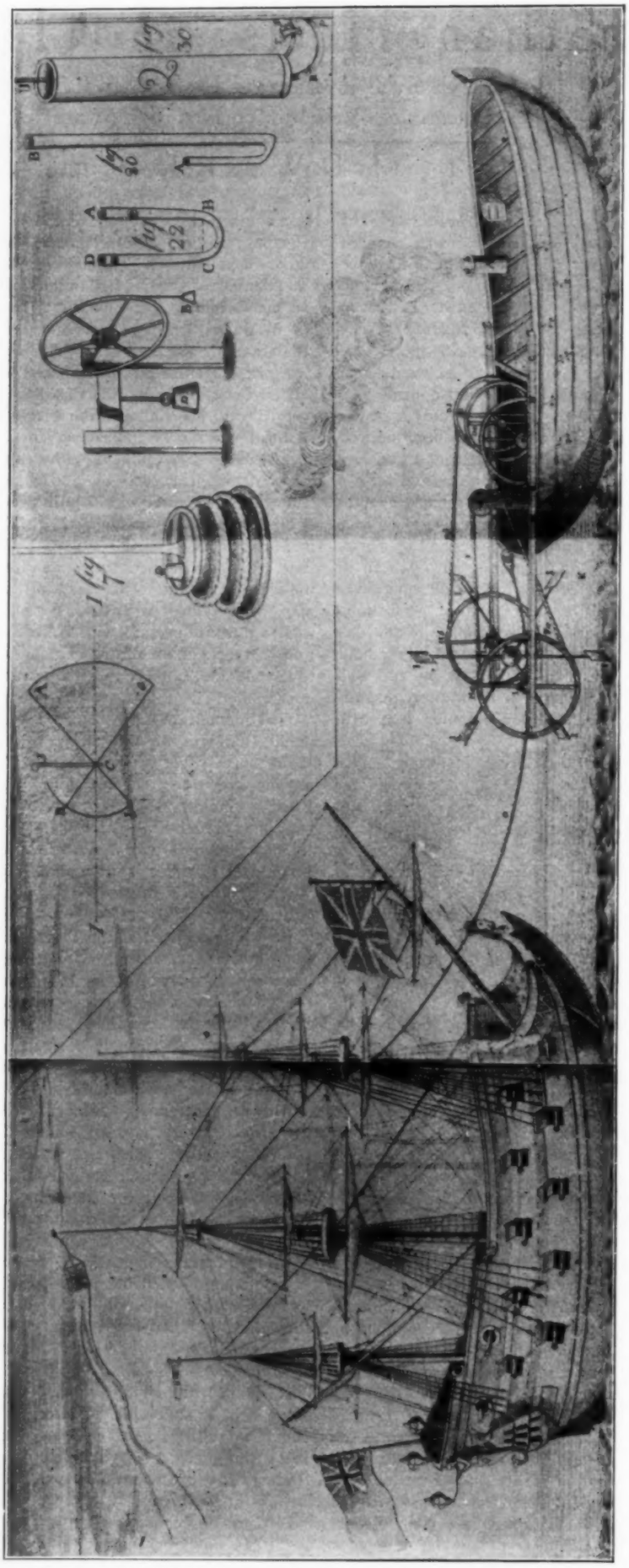
C C, Two pieces of Timber framed together to carry the Machine.

D a, *D* and *D b*, are three Wheels on one Axis to receive the Ropes, *M F b* and *F a*.

Note. *M* is the same Rope that goes into the *Cylinder*, Fig. 30.

H a and *H b* are two Wheels on the same Axis with the Fans *I I I I I I* and move alternately in such a manner, that when the Wheels *D a*, *D D b* move backward or forward they keep the Fans *I I I I I I* in a direct Motion.

F b is a Rope going from *H b* to *D b*,



PROPOSED APPLICATION OF JONATHAN HULLS' PATENTED METHOD (1737) OF STEAMBOAT PROPULSION

that when the Wheels *D a*, *D* and *D b* move forward, moves the Wheel *H b* forwards, which brings the Fans forward with it.

F a is a Rope going from the Wheel *H a* to the Wheel *D a*, that when the Wheels *D a*, *D* and *D b* move forward the Wheel *H a* draws the Rope *F* and raises the weight *G*, at the same time as the Wheel *H b* brings the Fans forward.

When the Weight *G* is so raised, while the Wheels *D a*, *D* and *D b* are moving backward, the Rope *F a* gives way, and the Power of the weight *G* brings the Wheel *H a* forward and the Fans with it, so that the Fans, always keep going forward notwithstanding the Wheels *D a*, *D* and *D b* move backwards and forwards as the Piston moves up and down in the Cylinder.

L L, are Teeth, for a catch to drop in from the Axis, and are so contrived that they can catch in alternate Manner, to cause the Fans to move always forward, for the Wheel *H a* by the power of the weight *G* is performing his Office, while the other Wheel *H b* goes back in order to fetch another Stroke.

Note. The weight of G must contain but half the weight of the Pillar of Air pressing on the Piston, because the weight *G*, is raised at the same time as the Wheel *H b* performs its Office, so that it is in effect two Machines acting alternately by the weight of one Pillar of Air of such a Diameter as the Diameter of the *Cylinder* is.

If it should be said that this is not a New-Invention, because I make use of the same power to drive my Machine that others have made use of, to Drive theirs for other Purposes, I *Answer*, The Application of this power is no more than the Application of any common and known Instrument used in Mechanism for new invented Purposes.

Answers to some Queries that have been made, concerning the Possibility and Usefulness of this Undertaking

Query I. ***Is it possible to fix Instruments of sufficient Strength to move so prodigious a Weight, as may be contain'd in a very large Vessel?***

Answer. All Mechanicks will allow it is possible to make a Machine to move an immense Weight, if there is Force enough to drive the same, for every Member must be made in a proportionable Strength to the intended Work, and properly braced with Laces of Iron, *&c.* so that no part can give way and break; if the Braces, *& c.* necessary for this Work had been put in the Draught, it would have been so much crowded with Lines that the main Instruments could not be so well perceiv'd.

Query. II. *Will not the Force of the Waves break any Instrument to Pieces that is placed to move in the Water?*

Answer. First, it cannot be supposed, that this Machine will be used in a Storm or Tempest at Sea, when the Waves are very Raging; for if a Merchant lyeth in a Harbour, *& c.* he would not choose to put out to Sea in a Storm if it were possible to get out, but rather stay untill it is abated.

Secondly. When the Wind comes a Head of the Tow-Boat the Fans will be protected by it from the violence of the Waves, and When the Wind comes Sideways, the Waves will come Edge-ways of the Fans, and therefore strike them with the less Force:

Thirdly. There may be pieces of Timber laid to swim on the Surface of the Water on each Side of the Fans, and so contriv'd as they shall not touch them, which will protect them from the Force of the Waves.

Up in-land Rivers where the Bottom can possible be reach'd, the Fans may be taken out and Cranks placed at the hindmost Axis to strike a Shaft to the bottom of the River, which will drive the Vessel forward with greater Force.

Query III. *It being a continual Expence to keep this machine at Work, will the Expence be answered?*

Answer. The work to be done by this Machine will be upon particular Occasions, when all other means yet found out are wholly Insufficient: How often does a Merchant wish that his Ship were on the Ocean, when if he were there, the Wind wou'd serve tolerably well to carry him on his intended Voyage, but does not serve at the same time to carry him out of the River, *& c.* he happens to be in, which a few Hours work of this Machine wou'd do: Besides, I know Engines that are driven by the same Power, as this is, where materials for the Purpose are dearer than in any navigable River in *England;* therefore Experience demonstrates that the Expence will be but a Trifle to the value of the Work perform'd by those sort of Machines, which any Person that knows the Nature of those things may easily Calculate.

An intersting statement appears in the *Engineering Magazine* showing the enormous freight-handling equipment employed by the railroads in and about New York harbor. In addition to the dozen railroads using tugs, lighters, barges, etc., for moving freight from one point in the harbor to another, there are some thirty independent companies engaged in the lighterage business. All told, the fleet operating in New York waters is an impressive one, amounting to fully 1800 vessels of various types. An idea of the total invested capital may be gained when it is stated that the value of one fleet, that of the New York Central, is close to $2,500,000. In the year 1900 this one road lightered 1,250,000 tons of merchandise freight, 59,000,000 bushels of grain, and towed 190,000 carloads of freight, equivalent to 4750 trains of 40 cars each.

Finishing Some Small Hardened Steel Tubes

By G. Hess

A and *B* represent the extremes of a series of hardened-steel tubes with finished holes ranging from 0.025 to 0.088 inch diameter with a variation of 0.002 inch between sizes. These tubes were made of a low grade of steel tubing having a variable aperture, the smallest of which permitted a 0.016-inch drill similar to *C* to just enter. The requirements were that the holes should be accurate, uniform and perfectly smooth throughout, also as straight as possible. The front end, as shown in the cut, was ground and lapped to 0.12 inch diameter and the remaining portion 0.126 inch diameter was left, excepting slight polishing, just as it came from the mill. The tubing came in lengths of about 6 feet, and was cut up to requirements and straightened to roll fairly well on a surface plate.

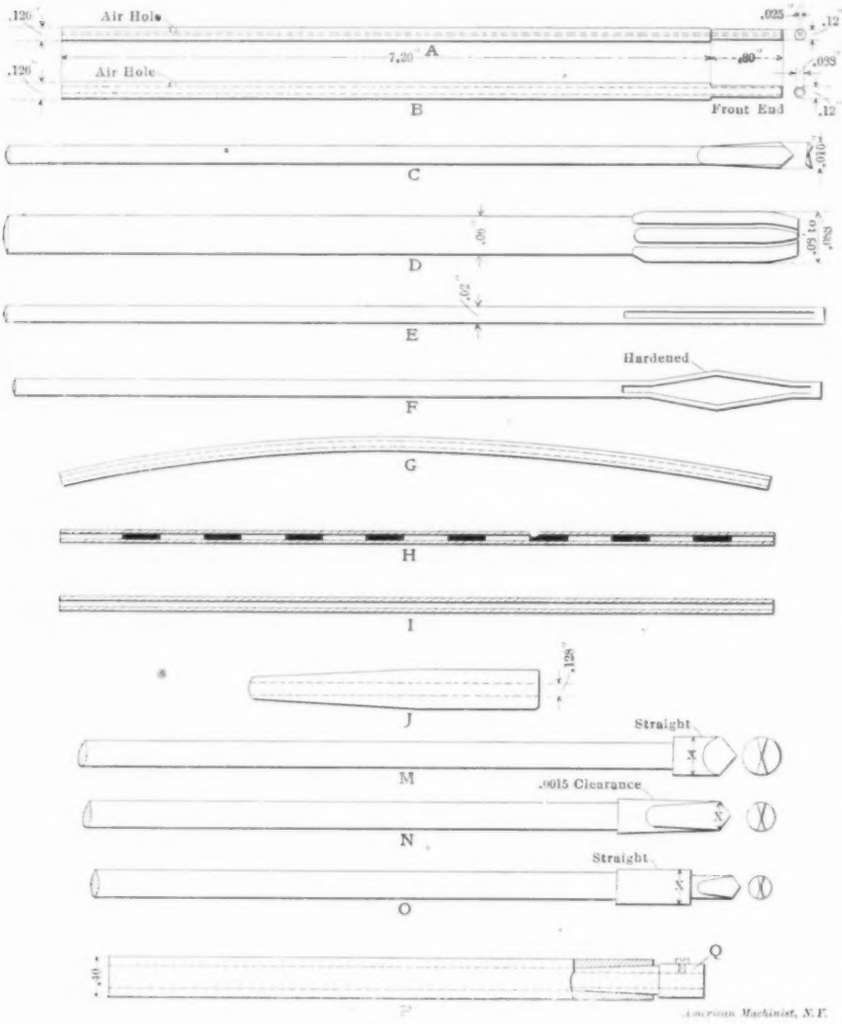
While working these tubes it was noticeable that the aperture was very nearly concentric with the circumference. Originally these tubes were made larger in diameter and drilled out of solid stock, and for this purpose the tools *M N O P* were used. *M* is the centering tool which is followed by *O* and in turn by *N*. A reamer like *D* finished the hole. The shanks of these tools fit the adapter *Q* shown in the spindle *P* which fits an open tailstock used in the bench lathe. Preparatory to using these tools the work was backrested and a center turned, drilled and bored to fit the diameter *X* on the tool *O* deep enough for it to enter and get started. This drill is then used to its limit, is followed by *N*, which in turn is followed by *M*. This process is repeated until drilled through. Now the same method was applied to the tubing, but experience showed that back-resting a piece of this character is a very unsatisfactory and uncertain procedure, proved occasionally by the premature exit of the drill through the side of the piece. Moreover, when the smaller sizes were reached difficulty was encountered.

At this point they were brought to me with a request to see what could be done with them. The idea suggested itself that it might be possible to raise the aperture gradually 0.0005 or 0.0006 inch at a time. This would preclude all possibility of the drill doing anything but follow the hole, which was all that was necessary as the aperture was, as already stated, nearly concentric with the outside and had to be kept so. Accordingly this method was tried and proved to be very successful up to 0.078 inch diameter. *C* shows the style of drill used. All sizes of these were made from 0.016 to 0.078 inch diameter, differing by 0.0005 or 0.0006 inch. These drills were easily and quickly made. The smaller sizes were simply hammered out

at the end while cold, then hardened and ground by hand on a diamond lap. For the larger sizes the flattening could be done under a press if desired, also double-enders could be made; that is, one piece of wire answering for two sizes. Some of these tubes were wanted to finish 0.025 inch, hence the tubing with the smallest opening was selected and operations begun with the smallest drill 0.016 inch diameter.

The method of using these drills is as follows: A Morse drill chuck mounted on a spring-chuck blank with a through hole was used. In this the drill was chucked and allowed to project a short distance and run at a high rate of speed. The tubing was held in the hands and presented to the drill (in the case of these small ones very carefully), and fed as far as possible. The drill was then gripped farther back and the process repeated. It must be admitted that this size, 0.016 inch, was a very tedious operation as the pulverized chips would clog in front of the drill and stop it.

This was overcome by bending a piece of 0.01-inch wire over at an angle of 30 or 40 degrees and passing it through the other end, which would scatter them. The tubes were carried along in groups. For instance, if six 0.025-inch tubes were wanted the 0.016-inch drill was passed through all of them first and then followed by 0.0165-, 0.017-, 0.0175-inch and so on in succession until the size wanted was reached. After passing a few of these drills through in the manner described, the process was comparatively easy, and became easier as the diameter increased up to 0.78 inch. Above this size, for some reason not yet determined, the results were not so satisfactory, although further experiment might explain the reason. However, five reamers, like *D*, were used in succession for the larger sizes, the reamers being used in the same manner as the drills, but varying in size by 0.002 inch.



THE WORK AND THE TOOLS

At best these reamers on this particular job required uniform lubrication and light feeding to make a uniform hole. If this was not the case the hole, after reaming, appears like *H*, the dark spaces in the cut corresponding to fine lines or threads in the tube. This was seen when the interior was exposed by grinding away one-half of the tube lengthwise. Ordinarily these lines or threads would have been of no importance, but lapping them out in this case becomes a slow, tiresome and expensive process; moreover, when the reamers become worn, too much is likely to be left for lapping, which further increases the cost. Not so with the drills.

I shows the uniform surface after using them, the threads or lines referred to were never present, and it was an easy matter to make a drill to the exact size needed, the last one being practically finished size, thereby reducing the lapping to a mere polishing process. As one of these drills is quickly passed through the tube it becomes possible to see just what is being done at any time and clearly has the advantage of the other method, which takes hours to pass through with no assurance as to the outcome. Many drills can be made in less time than it takes to make a single reamer like *D*, and since 75 per cent. of the reamers were discarded along with the other tools the great saving becomes apparent. A bunch of these tubes, finished with the drills, actually glittered when held toward the light.

A small air hole was drilled, as shown in *A* and *B*, and the tubes were hardened. As a rule, they returned reasonably straight, but *G* shows one of the worst. All were buffed off and drawn to a light straw, and quite low around the air hole. Straightening the tubes will hardly bear description, but one end was chucked in a spring chuck and the other entered the hole in *J*, which fitted the tail spindle of the lathe. A lathe tool was placed in the slide rest and with the aid of a spirit lamp, the part to be straightened was heated until the solder would melt when the pressure was applied through the slide rest screw. After a part was straightened it was passed through *J*, and this was repeated until the piece was finished. For testing, a surface plate was set up about level with the eye, and the tubes rolled along, observing the amount of light between the tube and plate.

Polishing out the holes was the next operation and was accomplished with the lap *E F*. A saw was sunk through the wire, as shown in *E*. The slot was then spread, as shown at *F*, and the piece hardened. Some diamond dust and oil was placed in the tube and the lap thrust in and worked until the required luster was obtained. An arbor was then turned or ground up in the chuck, and the front end (which was always the rear end when drilling) wrung on the other end being back-rested, then ground with the slide-rest grinder. After lapping to sizes 0.12 inch, the ends were ground off, as the tubes were left long to insure a perfect mouth. Placing the tubes in a suitable fixture, the ends were lapped off on a lapping block, thus completing the job, as required.

[Two samples of these tubes were sent to this office. They are a good job.—Ed.]

Practical Letters from Our Readers

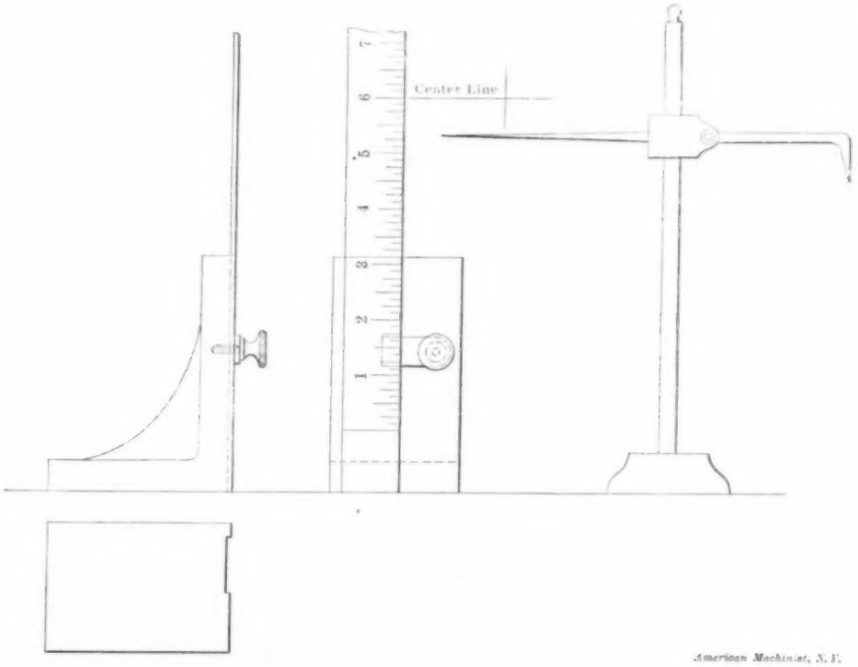
A Round Table Discussing Details of Modern Machine-shop and Drawing-office Methods, Practice and Economy

WE PAY FOR USEFUL IDEAS

A Scale Holder for the Surface Table

The accompanying cut shows a very simple but valuable addition to the tool kit of one who lays off work on the surface table, planer, boring mill, milling machine, or any other surface.

The angle piece is a true right angle. The vertical face has a recess planed to receive a standard scale. The size of the angle piece is governed by the length of the scale used, which in turn is governed by the size of the work laid off.



A SCALE HOLDER

In using this appliance the center line of the work is first located from the governing points in the usual manner, and then the scale is set and locked so that any particular graduation, the 6-inch line, for example, coincides with the center line. With the surface gage the different points and lines to be measured off can all be found at their respective distances above or below the center line without measuring from the table or base line each time. As drawings usually show dimensions from each side of the center lines, it can readily be seen that a great amount of figuring and chances of error are eliminated.

The above is specially true if the distance from the center line to the surface table is an odd dimension. Another advantage is that the scale is always perpendicular to the table, thereby insuring the measurements being taken off correctly with the surface gage. If the work is higher than the scale can accommodate, place the scale holder on any good parallel block and proceed as before, using any convenient graduation on the scale, setting it so that it will coincide with the center line.

This appliance could be used to good advantage by patternmakers for the same purpose by substituting a shrinkage rule in the place of the steel scale, and proceeding in the same way.

Cincinnati, Ohio. STANLEY.

To Make a Reamer Cut Large—Coppering Brass

Sometime it is necessary to have a hand reamer ream a thousandth or two large. If the cutting edges of the flutes are burnished with a hard-steel burnisher the edges will be upset and the reamer will then cut large.

Anyone can copper iron or steel, but few know this kink for coppering brass. Mix some iron shavings with the bluestone and you have a solution which will copper brass.

OSCAR JOHNSON.

Jersey City, N. J.

Special Collars for Milling Cutter Arbors

Everyone who has had anything to do with milling cutters screwed on the end of an arbor or direct on the milling machine spindle has most likely had his share of trouble in removing the cutters. The sketch, Fig. 1, shows a pair of spiral collars which are slipped back of the cutters. For a right-hand thread in the cutter the special collar must be left-hand and the collars must be kept apart at *A* a reasonable amount so that when the cutter is turned for removing it will back away the amount of the spiral on the collar. Before using these spiral collars I have been obliged to cut out a part of the hub of the cutter or the collar of the arbor before I was able to get them separated; now we have smooth sailing.

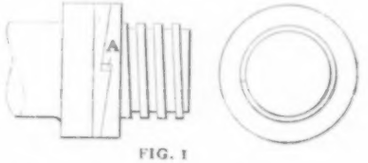


FIG. 1

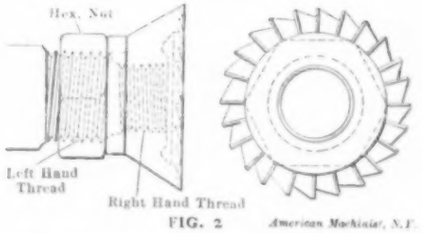


FIG. 2

SPECIAL COLLARS FOR MILLING-MACHINE ARBORS

Let me say also that in any case there should be a little graphite mixed with the oil that is put on the thread. Fig. 2 speaks for itself, and is practically the same idea in a different form. It is a delicate job to remove a sharp angular milling cutter as shown, but putting a nut back of it which is provided with left-hand thread for a right-hand cutter, as illustrated in the sketch makes it possible to remove or unscrew the cutter without damage to the cutter and by making the nut larger, as shown, it makes a strong job.

Milwaukee, Wis. G. J. LUCK.

Dimensioning Detail Drawings

There are a good many drafting rooms that have adopted a similar or almost similar standard of dimensioning their working drawings, but there are a great many more that have no standard at all. Judging from the blueprints that I handle every day, the latter seem to outnumber the former about ten to one. The fact that some of the blueprints are not dimensioned in any systematic manner would not be so bad if they would only give all the information necessary to make the piece or pieces shown on the blueprints.

Where all the work is done in the company's own plant, these omissions are not so very bad, because the missing information can generally be had by going or sending to the drafting room for it, but where part of the work is made by other firms—and many of these in other cities—it is an entirely different proposition, and one which causes a great loss of time and money for both parties.

I am at present with a firm that deals almost entirely in screw-machine products, and am in a position to see all the blueprints that are sent in for quotations, and with orders. As the screw-machine products of today are of a great variety, the blueprints received by this firm come from almost all classes of manufacturers and dealers in metal goods.

Fig. 1 represents only one of the many incomplete detail blueprints sent in to us, either to quote on or with an order. A blueprint of a piece similar to that shown in Fig. 1 was received by us with a request for quotation on lots of 1000 pieces. The drawing of this was certainly a fine piece of work from an artistic point of view. Anyone could tell that it was meant to represent a bevel-gear pinion. To quote intelligently from this blueprint is almost impossible. It is simply a piece of guesswork, unless the piece has been made before by the firm estimating on the job. This blueprint being sent in by an automobile manufacturer, it was assumed that the piece must be held within very close limits all over, that is, the hole must be a reamed hole, and that the 1-inch and ¾-inch diameters were bearing surfaces, and must have a good finish and be to size. The quotation was made accordingly.

A few days after the quotation was made, we received an order for 1000 of these pieces with directions to make them as per the blueprint that we had when quoting on the job.

When this blueprint came into the factory, it was found that all the dimensions necessary to make the pieces were not given. In this case, the blueprint was returned to the customer with a request that the width of face, the back or center angle, and the length over all be filled in. It was not safe to scale the blueprint, as a large stamp in one corner read, "Do not scale this blueprint. Work to the figures."

The customer being in another city, it took about three days to receive the information necessary to start on the order. Right at the start the customer lost three days because his blueprint did not have all the necessary information on it, and since he was in a hurry for the pieces, it set him back just that far.

The customer wanted one hundred pieces at once, and after these were delivered, we received a complaint from him stating that the pieces were not right. The 1-inch shoulder should have been a drive fit and therefore 0.002 to 0.003 inch oversize. His blueprint did not call for this, so the mistake was put up to him. We then received a new blueprint with directions to work from this print. This print showed the 1-inch shoulder to be a driving fit and the ¾-inch shoulder a running fit; also the hole need only be drilled and not reamed. The fact that only a drilled hole was wanted would increase the production per day, and of course, the price per piece decreased in proportion. In this case, had the draftsman given all the necessary information on the blueprint, his firm would have saved a week's time and considerable money, and we would have saved the time trying to find out what the customer really wanted.

This is only one of many cases where time and money are lost in this way.

Fig. 2 shows a piece dimensioned in a way that again causes a delay. It would be impossible to make up one thousand pieces like this on an automatic screw machine and have each piece come up to the dimensions given. That the pieces will vary from 0.001 to 0.003 inch on each dimension is certain, no matter how carefully they must be made or on how good a machine, so we have to return the blueprints to the customer with the request that he give us limits. Therefore, why not give maximum and minimum limits on each dimension.

There is bound to be some variation, no matter on what kind of a machine the pieces are made, and if the piece must be dimensioned in this way, the maximum and minimum tolerance should be given. It is only a few more minutes' work in the drafting room, and it certainly saves any amount of time afterward in the shop.

Fig. 3 shows a piece that caused a good deal of trouble. When the order for 2000

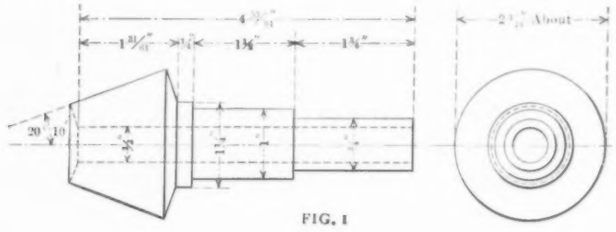


FIG. 1

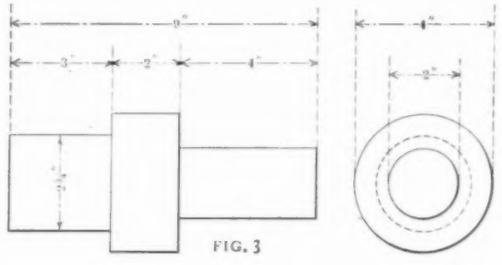


FIG. 3

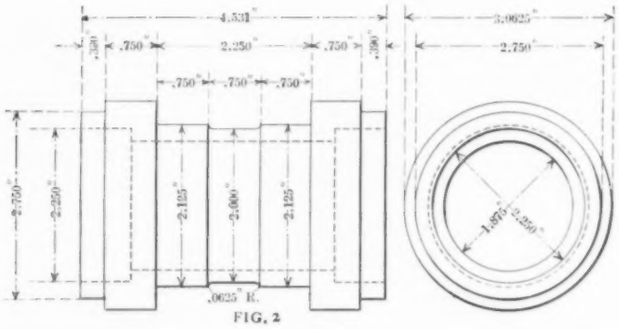


FIG. 2

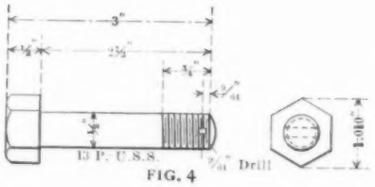


FIG. 4

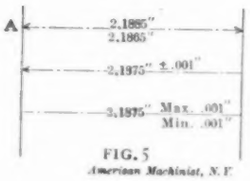


FIG. 5

DIMENSIONING DETAIL DRAWINGS

of these pieces was placed with us, it called for a screw-machine job and the quotation was based accordingly. Consider our surprise when the pieces were returned to us because the three shoulders were not concentric with each other. The middle shoulder and one end were concentric, while the other end was off center about 0.003 inch on the worst in the lot. Had it been stated on the blueprint that all diameters must be concentric with each other, we could have allowed for finishing between centers.

A number of times we have received blueprints of pieces similar to that in Fig. 3, and where we know that the middle shoulder is only used as a spacer, and to keep up the fitness of things, it is generally on these pieces that we are asked to make all diameters concentric with each other. Just why this must be when the outside of the large diameter touches nothing but air is hard to understand. Certainly the looks of the piece would not suffer very much if the middle shoulder ran out 0.003 or even 0.006 inch.

Will someone please state what advantage there is in dimensioning a detail drawing as shown in Fig. 4. It certainly is a great disadvantage to anyone who must work from it. How much easier it would be to read if the distance across the flats were given instead of across the corners. When given the distance across the flats, a man knows instantly that ⅞-inch hexagon stock is what he wants, and does not have to stop to figure it out.

Note also that the cotter-pin hole is located from the oval at the end of the screw. Fine job for a man to measure, when given in sixty-fourths, as in Fig. 4. It is just as easy for the draftsman when detailing, to give the distance from under the head to the center of the hole, as it is to give it as in Fig. 4, and it certainly makes it a great deal easier for the man in the shop.

So please, Mr. Draftsman and Mr. Checker, when you make and check your detail drawings, put yourself in the place of the man who must make the parts that you make pictures of. Ask yourself how you would make the pieces if you were out in the shop running a machine. Just do that for about a month, and you will be surprised at the little things that you leave off of your detail drawings, and which are very necessary to the man at the machine. It will take only a few minutes more of your time, and you save the other fellow a great deal of time and worry, and at the same time receive his heartfelt thanks.

As it is now the aim of every manufacturer to make his product interchangeable, it would be well if some sort of system could be adopted whereby all unimportant dimensions would be given in inches or fractions thereof, and all important dimensions in decimals. A good many manufacturers do that now, but they are in the minority. When giving the dimensions in this way, if they would at the same time give the maximum and minimum amount of tolerance allowed on each decimal dimension, it would save a great deal of scrap material.

This question of dimension limits is one that should be considered very seriously, and especially by those manufacturers who have a good part of their work made outside of their own plant. It will give them a more uniform quality of work, and will enable them to check up their own work better.

Looking at it from the standpoint of the manufacturer of screw-machine products, it is very important that these limits be given on all work that must be held close to a stated size, as it enables him to figure closer when quoting on work, because he then knows just how close he must work.

But the giving of limits can also be abused. It is worse than useless to give a limit of + 0.0005 inch or — 0.0005 inch on the length of a shoulder, because there is that much and more play in the spindle of any screw machine that has been in use at all. Therefore, it is well to be as liberal as possible in giving limits. Liberal limits, where they can be safely given, as a general rule simply mean an increased production for us and a lower price on the goods for the customer. When the limits are small, the reverse is equally true on account of having to watch the tools more closely, and the changing of them when they wear.

Some manufacturers have already adopted the dimension-limit system and that has brought out a variety of standards, of which the three shown in Fig. 5 are the most used. The standard shown at *A*, Fig. 5, is the one that has been adopted by this firm, and we have found that it works very satisfactorily. It shows at a glance the two extremes that this dimension can be worked to, without any unnecessary adding or subtracting on the part of the machine setter and operator. It also reduces the chances of mistakes in setting gages and micrometers. However, it does not matter much what standard is used to indicate the limit allowed on each dimension as long as they are given where accurate work is wanted.

There is a little more information that every screw-machine product manufacturer would like to have when making up parts: The subject of finish is one that should be put on every detail blueprint. It is well to know just what kind of a finish is desired when quoting on an order. There are some pieces where a very good finish is desired, while on others the finish does not have to be as good. Where a very fine finish is wanted, it means a more frequent changing of tools, and where the order is a large one, this is quite an item.

It very often happens that we get an order from a customer for a number of different pieces and some of these pieces fit together. As each piece is generally on a separate blueprint, we have no way of telling what parts fit together. If, however, this information was noted on each of the blueprints of the parts that fit together, and also the character of the fit, it would save a great deal of time and trouble. Especially is this true where the pieces must be a running fit together and no limits are given.

Another point, and one that is a money saver for the customer, is that of making all reamed holes a standard size. When an order is placed for special pieces where the hole is reamed to 0.005 or 0.006 under a standard, it usually means that we must make a new reamer to that size or grind a standard reamer down to the required size. This, we try to avoid wherever possible, because the reamer is usually useless after one job is finished, since we may never get another order for parts with reamed holes of that special diameter. Hence, it is always best to make the hole standard and the male part oversize when a drive or press fit is wanted.

In this article it is desired to show some of the things that could be changed for the better from the point of view of the manufacture of screw-machine products. This line of business is nothing more than a large jobbing shop, and we no doubt have the same troubles that all jobbing shops have, only we get more of them. The variety of work that a screw-machine product concern handles is perhaps greater than that of any other in the metal-working line. The work ranges from turned parts for harvesting machinery to that required by the fine machine-tool manufacturers. It can readily be seen that in receiving on an average of 50 to 100 inquiries for quotations and orders daily, and each from different concerns in a different part of the Middle West, we have our hands full trying to figure what the customer wants, if his blueprint is not plain.

I hope that this may stir up a little discussion on the question of putting limits on detail drawings where accurate work is desired, even if that work is not done outside of the manufacturer's own plant.

Detroit, Mich. P. H. HENNING.

The smelter production of lead in the United States in 1908, as given by C. E. Siebenthal, of the United States Geological Survey, under date of May 24, was 408,523 tons of 2000 pounds, against 442,015 tons in 1907, and 418,699 tons in 1906. The production of refined primary lead, which embraced all desilvered lead produced in the country, and the pig lead recovered from Mississippi Valley lead ores, was 396,433 tons against 414,189 tons in 1907, and 404,669 tons in 1906. The antimonial lead produced was 13,629 tons, and the recovered or secondary lead 18,283 tons. In 1908 the lead smelted from domestic ores was 310,762 tons, and from foreign ores and foreign base bullion (almost wholly Mexican), 97,761 tons.

Discussion of the Previous Question

Letters from Our Readers Showing How Many Men of Many Minds Look upon Various Subjects Opened up in Previous Numbers

WE PAY FOR THESE ALSO

Some Points in the Hobbing Process

My article on the Humpage patent hob with inserted blades, page 126, Vol. 32, Part 1, has brought forth letters by Walter G. Groocock, page 584, and H. A. Wilson, page 754, of the same volume and part. The whole subject of hobbing is one of extreme difficulty and is little understood even by those who have had great practical experience with the process. I must, however, try to answer some of the points brought up in these letters.

In the first place, speaking of "accuracy" we are now talking about a matter of less than 0.001 inch, which is quite sufficient to make all the difference between quiet-running and noisy-running gears. Mr. Groocock asks why we should strain after the correct involute which, when produced, gives noisy running. Now, in this, I entirely disagree with him, for were it possible to produce a correct involute we should have quiet running teeth. It is because the ordinary hob used in the ordinary way does not cut a true involute that it is better to finish the teeth by running through a light finishing cut with a cutter shaped to the correct number of teeth. At the same time I do not admit that a wheel cut entirely with a formed cutter would run more quietly than a hobbed wheel, as the latter would be truer in pitch.

It is quite true, as Mr. Groocock says, that teeth cut with standard cutters have a clearance from the correct curve at the points, and also that by getting away from the straight-sided hob we can make a hob that will clear away the tips of the teeth in the same way. He is also perfectly correct in saying that this makes for quiet running, but when the tips have been cleared away in this manner of what use are they at all? Since they do not touch, would not the same effect be produced by putting the wheel in a lathe and turning off the tops of the teeth altogether? Also as the teeth wear will they not in time wear to the true involute form even if the points were originally eased off? The reason that most hobbed wheels are noisy at first is not that the teeth are true involutes, but that too much metal has been left on the points of the teeth. As they wear to the correct involute form they become more silent, and it seems clear to me that the ideal to aim at is to cut the teeth to the true involute in the first instance. In the case of bevel wheels it is admitted that the best work is done by planers of the generating type, such as the Bilgram or the new Gleason. Both these machines generate teeth of the true involute form, and it seems clear that what is best for bevels should also be best for spur wheels.

The reason why an ordinary hob leaves too much metal on the points of the teeth is not hard to see. Take an ordinary two-pitch hob and lay a straight-edge along the top of the teeth parallel to the cutting face. Owing to the spiral twist there will be a slight rock in the straight-edge. These teeth in fact do not form a rack at all, but have been bent into the arc of the circle. Hence if we scribe a line down the center of the face of each tooth these lines are not parallel, and the pitch measured at the points of the hob teeth is greater than if measured on the pitch line. The points of the hob teeth are, in fact, too far apart and a small portion of metal that should have been removed is allowed to remain.

Swiveling the Hob

To cut a silent gear wheel with an ordinary straight-sided hob the hob should be swiveled to rather more than the angle stamped on it. About 5 feet on a three-pitch hob of angle 2 degrees 55 minutes would be a fair allowance. The extra swiveling, of course, gives rather more clearance on one side of the hob teeth than on the other, but this is of no importance. In this connection it may be noted that an ordinary hob has the angle to which it should be swiveled stamped on it once and for all. Yet as we grind the teeth back we are reducing the diameter of the hob owing to the backing off and so, strictly speaking, we should increase the angle to which the hob is swiveled after each grinding.

The extra swiveling also means that the teeth are cut slightly thin and, of course, if we increased the swiveling very much we should cut the teeth away altogether. Apart from these defects, which are bad, the extra swiveling shortens the pitch of the hob. Thus suppose we are cutting a 38-tooth wheel, 8 pitch. The blank is turned to 5 inches diameter in the ordinary way, but when the hob has been swiveled to a little more than the correct angle the pitch is slightly less than 8 pitch. Hence we get a tooth with a long involute, approximately, to the form No. 1 in Mr. Humpage's article on, "A Gear System with Unequal Addenda," Vol. 21, Part 1, page 385. In our own works this extra swiveling is always given whenever an ordinary hob is used, with excellent results in practice.

But all this trouble and guess-work is avoided in the Humpage patent hob, owing to the fact that the blades are not spiral, but perfectly straight and parallel to the axis, like the teeth of a tap. They are, in fact, true racks, and generate teeth of the correct involute form. In the case of the finishing hob described in my previous article no swiveling at all is necessary as the angle is so slight. This means that the clearance angle differs on the two sides of the teeth, but as I have just said, this is of little importance.

Action of the Teeth of the Hob

Mr. Groocock makes a curious mistake in giving as a disadvantage of the finishing hob the fact that all the teeth come into action together. Of course, this is exactly what happens with an ordinary hob slewed to the angle of its spiral. But the finishing hob is a refinement which few makers will feel disposed to go in for. In the case of Humpage patent hobs of ordinary diameters it is, for the sake of giving proper clearance, necessary to slew the hob. In this case the teeth do not come into action simultaneously, but a fraction of time behind each other, while the slewing causes the cutting angle of one edge of the hob tooth to be different from that of the other. However, in practice the hobs are found to cut well.

Mr. Groocock wonders whether a built-up hob can be made as accurately as a solid hob. Mr. Humpage's main idea was to produce a hob which could be ground all over after hardening, and thus correct the distortion which always takes place in the hardening process. In the case of large pitches I have no doubt that the built-up hob has a very great advantage over the solid hob.

Turning to H. H. Wilson's letter, page 754, he appears to have drawn the conclusion from my previous article that the hobbing machine is a failure. I cannot see that I have said anything to lead him to this opinion, as I tried to make it clear that as far as the spacing of the teeth was concerned, no other method is as accurate as hobbing. It is only in the shape of the individual teeth that it falls short of perfection. I have already said a great deal on this head in the present article. Mr. Wilson is quite right in saying that wheels cut on a Fellows gear shaper show con-

tact near the pitch line only. The same thing is observed with wheels cut by "corrected" hobs. In both cases too much metal has been cleared away from the points of the teeth.

The Question of "Flats"

The flats which I spoke of in my previous article are not those to which Mr. Wilson refers. Even if we could make a perfect hob and a perfect machine we should still find that the involute consisted of a series of minute flats because the curve is not generated continuously, but is plotted as it were by the successive action of the blades. For this reason the finishing hob was designed with a large number of blades so as to increase the number of plotting points. But these flats are so minute and the corners so soon wear down that they may be neglected for general work. The flats of which Mr. Wilson speaks are more serious. The first cause that he mentions is that chips get between the cutting edges of the hob and the work. This produces scoring, but on hobbing machines of the vertical type with a good stream of suds the trouble from this cause is very slight.

I cannot quite understand Mr. Wilson's second point as to the hob having too much movement before it takes up its cut. Surely when the backlash is once taken up the cutting takes place continuously. In any case this is only a matter of design.

Mr. Wilson's third point is the torsion of the shaft. I do not think that this produces flats, but it certainly is a very serious matter, and causes one side of the teeth to be convex, and the other concave. As the hob gets into its cut the shaft springs more and more, causing the hob to lag behind the work and as the hob is coming out from the work the shaft springs back, causing the hob to gain on the work. This again is a matter of design. A stiff machine will cut gears in which this convexity cannot be detected. This was one of the chief points looked after in designing the hobbing machine made by my firm.

The large flats which can be seen on many hobbed wheels can only, I think, be caused by defects in the hob. Either one blade is more prominent than the others or the hole is not ground true with the thread so that the hob runs eccentrically. Whenever these flats are found the spiral of the thread should be tested, and it will probably be found that as the hob revolves the thread shows a distinct wabble. In the case of hobs carefully made by a good maker the flats will not be found. It is here that the difficulty of hardening comes in, and that the advantages of the Humpage hob, that can be ground up after hardening, will be most apparent.

Bristol, England. P. A. Thompson.

Brazing Conical Tubes

In reply to the inquiry of F. W. Brady, on page 982, I would suggest that he take a pair of strap hinges and mold a block of plaster of paris around them; allowing enough space on top to have about two inches of stock on each side of the tube.

When thoroughly dry finish hole to the shape of cone, then cut through to the hinges from top and bottom, and cut enough stock away below to allow the hinge to open, to insert the tube.

Finish the top nearly level with the tube and widen the slot about 0.25 inch each way from the seam.

Insert formed tube and clamp with tongs or "C" clamp. Apply heat from a blow pipe and braze in the usual way.

If the hole is not to be finished after brazing, a mandril can be made, of plaster, over a bar of brass or steel and inserted after clamping. This should do the work conveniently but the form must not be dipped in water while in use.

Cleveland, O. B. A. De Mutte.

Machine Supports

I have spent all my spare time for the past week trying to figure out whether Mr. Collins, at page 894, when he took exceptions to my plea for a one-legged lathe, meant to imply that the weight of the cone pulley would be so great as to make the head end of the lathe sag, or whether he thought that the upward pull of the belt would make it rise.

Taking an 18-inch lathe that I am somewhat familiar with I found that for comfortable working the belt had to be tight enough to barely lift the head from the bed if the bolts were loosened. A man might easily want the belt tighter; then again, on a larger lathe the belt tension might not always lift the head from the bed. On a smaller lathe the belt tension will surely exceed the weight of the head. The thing which leads us to bolt the head down on a large lathe is the pressure of the cutting tool which might also have an equal value near the tailstock. So far as the mere weight of the headstock is concerned I found that with a very ordinary pattern of lathe bed with a headstock that weighed complete 200 pounds the deflection at 50 inches overhang was only 0.00025, which is less than that which would be produced by the cutting tool by so much that I feel inclined still to think the bed might have equal overhangs at each end with good taste.

Dixie apparently overlooked the fact that I did not consider a tree a very solid proposition. I have one that looks the part all right in the summer, but when one of our ice storms comes along touches its topmost limbs to the ground. With his banyan tree I am by no means sure how many are legs, and how many are tension members. It seems to me also that these trees grow in places that remind me of a floating island where I used to go fishing; when the float bobbed you could not be sure whether you had a bite or the fellow over the other side had slapped a mosquito.

Springfield, Mass. Entropy.

A Belt Drive Change

On page 751 I notice a rather extraordinary belt drive, which I feel sure (from experience) will sooner or later give trouble, besides absorbing considerable power. My experience has taught me to avoid jockey pulleys as much as possible; even rope drives are better without them and ropes are more flexible than belts. Pulleys arranged as shown in Fig. 2, page 751, will add four times more bending and distortion, hence wear and tear, to the belt than the Fig. 1 arrangement, and it only adds 12 to 15 per cent. to the contact surface.

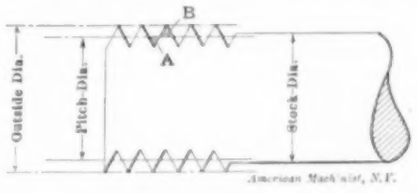
I would, therefore, like to mention to Mr. Anthony two other ways which might be adopted if Fig. 2 should give any trouble; first, the one which seems the more simple and, therefore, cheapest would be to increase the diameter of both main and countershaft pulleys 15 to 20 per cent. This would give a greater belt velocity, hence more power. Second, increase the width of pulleys and belt and let the diameters remain the same. As a third remedy which I once applied where a belt gave a lot of trouble by being overloaded, I duplicated the pulleys and ran two 3-inch belts, and all trouble was ended.

H. Mapplethorpe.

Darlston, England.

Thread Rolling Dies

Referring to Mr. Moriarty's article on "Thread-rolling Dies," at page 403, I note that he has made the mistake that is often



THREAD ROLLING DIAGRAM

made in calculations regarding the size of stock to be used in the process of thread rolling, that is, assuming the amount of metal displaced will fill the upper part of the thread. A consideration of the accompanying sketch will, perhaps, make this better understood.

Now, while *A* and *B* have the same sectional area, the area of the volume in one turn of the ring is not, however, the same, due to the center of gravity radius of *B* being greater than that of *A;* this, therefore, will require a diameter of rod somewhat larger than the pitch diameter depending on the pitch of the thread rolled.

For a more extensive calculation in regard to this subject I would refer Mr. Moriarty to an article by F. Webster, at page 630, of the October 31, 1907, issue of AMERICAN MACHINIST, entitled, "Size of Stock for Bolts Having Rolled Threads," from which this sketch is derived.

F. C. SCRIBNER.

Greenfield, Mass.

Cause of Die Breaking After Hardening

It would be extremely difficult for anyone to give a satisfactory explanation as to why Mr. Davis' sectional die burst, as referred to on page 952. There are a great many things entering into the problem of hardening a die with safety, or for that matter any tool. First the designing of a die has much to do with the amount of care that will have to be taken in the hardening. Sharp corners should be avoided. One surface should not be much greater than the other where a die is made, such as Mr. Davis' sketch shows.

The pieces 1, 2, 3 and 4 should be dipped with the back entering the bath first, giving it a second or two, as the back would cool slower than the front or cutting edge, then by plunging the entire die in the bath, both sides will cool in about the same time, thus preventing a strain being set up as the die is hardening.

It is well to remember in cooling a die of this kind that it is ⅛ inch longer per 12 inches, than it will be when cool, also that should there be 16 inches of cooling surface on one side and 12 inches on the other, unless the 12-inch surface has been given some advantage over the 16-inch surface, the 16-inch surface will overpower the 12-inch and cause the piece to change its shape, as well as set up strains that would be surprising if we knew their force.

In order to illustrate this force let us suppose the piece of Mr. Davis' die that burst to be 10 inches on one side and 8 inches on the other by 1½ inches thick and 4 inches wide, then, let us heat the piece to a hardening heat and dip with the 8-inch surface entering the water first. We will find that the 10-inch surface has placed a strain on the 8-inch surface that will spring it several thousandths out of its original shape and the 8-inch surface will be several thousandths longer after hardening. If we think of the force it would require to bend the piece in this way, should it not burst?

Then there is the forging of a piece of steel which is of vital importance in the hardening. If the tool has been forged at a higher heat than it should be, it is liable to burst, crack and check in the hardening. Where it is possible the steel should be purchased annealed, and the proper size for the tool. It is well to remember when forging a piece of steel, that when there is an uneven heat it means an uneven grain in the steel, unless the entire piece is brought to a heat as high as the highest heat that any part of the tool has had in the forging.

In guessing as to why Mr. Davis' die burst I would have to make several guesses as it is almost always necessary to see the piece and the grain of the steel before an intelligent idea can be given, but I wish to say that the die did not burst because it was placed on a cold anvil, as it would have broken lying on the bench or hanging suspended in the air. It might not have broken if it had been left in the oil until thoroughly cool, or an uneven heat might have caused it to burst. The heat might have been even when dipped, but should it have gotten a little warmer in some places than desired and the fire then checked to let the hot part cool to an even heat, the die would have burst it left in the oil.

There is one point which is usually overlooked in the heating of a tool for hardening and that is giving the piece sufficient time in the heating, thus allowing the heat to penetrate to the center of the piece. As near as I could judge a single piece of Mr. Davis' die should have one and one-half hours in the heating, and this is placing the time at the minimum if the piece of die be 1½x5x10 inches. If the heats were right, we would say the piece should have been left in the oil until dead cold. In conclusion I want to say that should Mr. Davis have given the exact size of the piece and told us what kind of steel, as to the carbon, he was using it would then have been possible to have given him some help.

Davenport, Iowa. C. U. SCOTT.

Transferring Holes

The kink given by Mr. Davis on the above subject, on page 751, is reliable where only reasonable results are needed. But as soft stock is used, burred up in the manner described, the circle formed has the disadvantage not only of being thick, but of lacking uniformity, for the reason that the wear on the point increases during the course of the circle, especially on unfaced gray iron, thus making it difficult to obtain accurate results. A better way, though not quite so cheap, perhaps, is to drill a small hole in the end of the stock and drive in a pointed piece of hardened steel, thus a much cleaner circle will be obtained.

Another method I have used has both rapidity and accuracy. Take a twist drill the size of the hole, that is correctly ground, insert it point first, noting that one of the grooves at the point is directly facing the operator, then give it a slight tap with a hammer, thus making a mark with the chisel-shaped end of the drill; repeat the operation with the groove turned at right angles to the former position and a neat cross is obtained which, if carefully centered and a circle described with dividers, should result in satisfaction.

Leicester. E. W. H.

Effective Organization in the Assembling Department

I was greatly amused at Terry's account, on page 1030, Volume 32, Part 1, by the discussion that followed the "dour Scotchman's attempt to revolutionize the assembling department and bring it up to efficiency." Unfortunately, the conditions existing in Ireland were not taken into consideration when the article was written.

It would be interesting to know the nationality of the "chief," which Terry failed to state, but possibly, if the heads of the departments in the shop in question were all of one breed, it would not be necessary for the "chief" to study the "War of the Worlds;" although under this condition no healthy rivalry would exist and the expected saving of time might never materialize. While the kind of discussion that resulted was different from what was anticipated, it is hoped that the article will not be the cause of shedding any "blood" nor of sending any of the "damned aliens to the bottom of the Irish sea."

But let us revert to the real cause of all the trouble and analyze the conditions that led to the "war." Was it due to the Irishman's becoming so attached to the jigs and fixtures that he could'nt bear to trust them to the tender care of the "dour Scotchman" in the assembling department or was it because the Irishman, being conscientious, feared that he might not earn his wages with less work to do? In all probability some time would be saved by keeping the jigs and fixtures near the drilling machines, especially if the tool room was inaccessible, and the jigs and fixtures were large and required crane facilities for handling. However, unless the Scotchman would take as good care of them as the Irishman evidently did, "every devil of a man of thim had better come back to the tool room."

Now as to the advisability of moving the store room with its "1300 different castings" into the assembling department, I doubt if it would "save years of time" were this an accomplished fact. The main

feature to be considered, in fact the vital point, is not so much the location of the store room, as it is the *necessity for one*, and for some thorough system of keeping track of the parts (especially the smaller pieces) as they are received from the various machine departments. This is the feature I emphasized in the article referred to, since there are many assembling departments today where the principle source of lost time can be attributed to this neglect.

It is inconceivable, how it would save time in assembling by having the machine room in the assembling department, since it probably would be rather crowded and besides, the Irishman might take a notion to move in too, all of which would tend to make Bedlam and drive the "chief" to suicide. In view of all these disturbing elements, it would seem wise to call off the "war" and allow the shop to again settle down to a dead level of production. Then the "chief" could substitute a study of the "Peace of the Nations."

For the benefit of those who are not "armed to the teeth and brave enough to ask the question, what is assembling?" here is the answer: Assembling is the operation of combining and adjusting the separate parts of each unit in such a manner that these units, when in combination, will properly perform a predetermined function. The operation of assembling should not include any unnecessary "fitting," due to poor machine work, and this probably is what put the "inoffensive Englishman" (the machine foreman) "between the devil and the deep sea."

ALFRED SPANGENBERG.

Plainfield, N. J.

Making a Small Stud on the Automatic Screw Machine

At page 935, Part 1, J. V. O. has an article on the above subject. His idea is all right but as there are some jobs which it is necessary to do by the two-per-cycle method to get the greatest production his objections to this method should be corrected so as not to lead anyone astray.

He speaks of a variation in the hights of the cam lobes of 0.005 inch making an error of 0.010 inch in the work. If he is using the machine correctly this will not be so.

On all forming on the screw machine the positive stops for the cross slides should be used which hold the cross slide firmly in position under about 0.008 tension while the highest point of the cam goes by the roll on the cross-slide lever; so 0.005 variation in the hights of the cam lobes would not make more than 0.001 difference in the diameters of the parts being made.

If the parts are wanted closer than this the cam after case-hardening should have the hole ground out to size and then have the dwell on the last points of the lobes ground true with the hole which will produce as accurate work as is possible with single-lobe cams.

In regard to the revolving of the turret by the empty holes, when wishing to index the turret a number of times in the shortest possible time with the least shock, he should discard the individual dogs for tripping levers and use but one long dog which will rotate the turret continuously the required number of holes without any shock or jar.

By the method I have outlined above there is no need of having the cams with 0.005 inch variation in the lobes and it would not be necessary to have so much tension on the stops for the cross slides with the cams properly made.

PAUL W. ABBOTT

Wilkes Barre, Penn.

Drilling Holes in a Casting Too Large for the Swing of the Drill Press

The article on page 842 interested me considerably. It seems to me that Mr. King's method of doing the job must have been rather expensive when one takes into consideration that three men were used to do what by right ought to be only one man's work. Some years ago I had a similar experience in drilling some molds. There were six of these molds to make, each one consisting of three plates and in each one of the three plates were 280 holes, making in all, quite a considerable job of drilling. We found that the swing of our drill press was too small by several inches. I then devised the rig shown in Fig. 1. *A* is the quill of the drill press. *B* is the end of the spindle. *C* is a taper plug fitting the taper hole in the nose of the spindle and having on its end a crank piece. *D* is an arm clamped to the quill of the drill press and having at its end a center underneath for the ratchet-brace

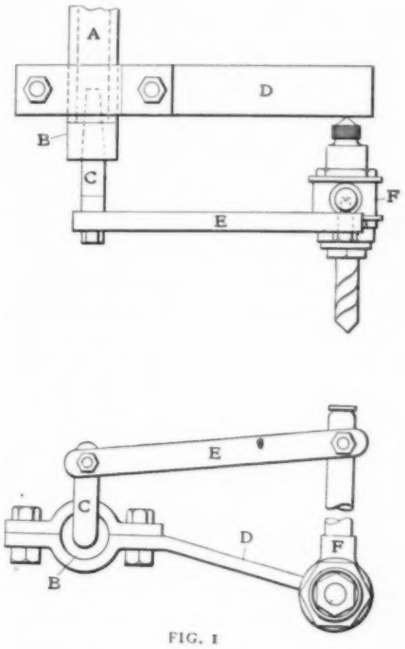


FIG. 1

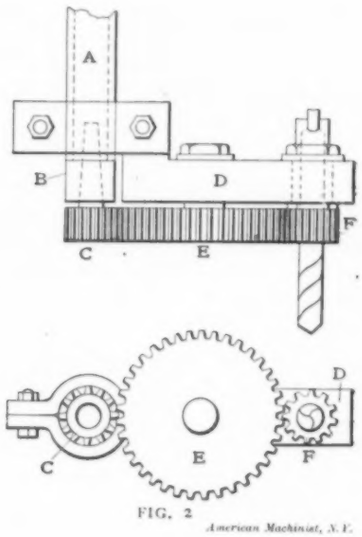


FIG. 2

American Machinist, N.Y.

DRILLING HOLES IN A CASTING TOO LARGE FOR THE SWING OF THE LATHE

center to work in. *E* is the connecting rod connecting the end of the crank *G* with the handle of the ratchet brace. It will readily be seen that when the ratchet brace was set in place the feed on the quill would feed both the clamp *D* and the ratchet *F* and the crank *C* down simultaneously, drilling the holes with one man only. While the job was proceeding with this makeshift which took about three hours to fit up the rig shown in Fig. 2, was being built and was, when complete, used for the same purpose and, subsequently, on many jobs which were too large for the swing of the press. Similar letters in each figure refer to similar parts with the exception that *C*, in Fig. 2, is a gear instead of a crank. *E* is an idler here instead of a connecting rod and *F* is a drill socket with a gear formed on the end of it instead of the ratchet brace, shown in Fig. 1.

On another job which would come under the head of "special," the idler *E* was removed entirely, sprockets were substituted for the pinions *C* and *F* and a chain took the place of *E*.

New York. E. A. DIXIE.

AMERICAN MACHINIST

Issued Weekly by the

Hill Publishing Company

JOHN A. HILL, Pres. and Treas. ROBERT MCKEAN, Sec'y.

505 Pearl Street, New York.

Correspondence on mechanical subjects solicited and paid for. Name and address must always be given—not necessarily for publication.

Subscribers can have address changed at will. Give old and new addresses.

Subscription price $4 per year, postage prepaid, to any post office in United States, United States possessions and Mexico. $5.50 to Canada. $7 in all foreign countries except Europe and British possessions in Eastern Hemisphere.

Hill Publishing Co., Ltd., 6 Bouverie St., London, E. C., will serve all subscriptions for Europe and British possessions in Eastern Hemisphere. Price 30 Shillings for England. For all other countries in Eastern Hemisphere, 35 Shillings.

Entered at New York Post Office as mail matter of the second class.

Cable Address, "MACHINIST," N. Y.
Business Telegraph Code.

CIRCULATION STATEMENT

During 1908 *we printed and circulated* 1,205,750 *copies of the* AMERICAN MACHINIST.

Our circulation for June, 1909, *was (weekly, monthly and European)* 91,250.

July 1	34,000
July 8	19,000
July 15	19,000
July 22	19,000

This paper reaches 34,000 *separate readers each month and* 19,000 *each week.*

None sent free regularly, no returns from news companies, no back numbers. Figures are live, net circulation.

Contents

	PAGE
The Making of Incandescent Lamps	141
High-Speed Steel in Sammy's Shop	145
Gating and Molding Grids	146
Permanent Molds for the Foundry	148
The Producer Gas Plant of the Philadelphia Gear Works	153
Getting to Work After Commencement	155
Experiments with Gases for Carbonizing	156
A Double-rate Premium Plan	158
File Teeth	160
Jonathan Hulls and His Steamboat	161
Finishing Some Small Hardened Steel Tubes	164
Practical Letters From Our Readers: A Scale Holder for the Surface Table....Coppering Brass....Special Collars for Milling Cutter Arbors....Dimensioning Detail Drawings	165-167
Discussion of the Previous Question: Some Points in the Hobbing Process....Brazing Conical Tubes....Machine Supports....A Belt Drive Change....Thread Rolling Dies....Cause of Die Breaking After Hardening....Transferring Holes....Effective Organization in the Assembling Department....Making a Stud on the Automatic Screw Machine....Drilling Holes in a Casting too Large for the Swing of the Drill Press	168-171
Mathematics and the AMERICAN MACHINIST	172
New Tools and Machine Shop Appliances	173

Index

The index to Part 1, Volume 32, is being mailed to all subscribers with this issue. Those who desire an index and are not on our regular subscription list, can secure one for the asking.

Mathematics and the American Machinist

On those who do not read mathematics, articles containing mathematical work seem to act very much like the traditional red rag on a bull. Criticism of the policy by which such articles are published occasionally in these pages has been continuous since the earliest days of the paper and it has been unusually vigorous and insistent of late.

Because of this we have measured up the space covered by articles of this class during the six months just past, the finding being that the total space thus occupied aggregates 5.6 per cent. of the entire reading matter. In making these measurements the entire length of all articles containing mathematics, even though the mathematics occupies but a few lines of a long article, was taken—the total being thus the space covered by the articles and not that covered by the mathematical work. Of the twenty-six numbers comprised in the half year, eleven contained no mathematics whatever.

Of how many of the other periodicals which our readers buy can they say that less than six per cent. of the contents has no value to them and how reasonable would they consider a criticism of any other kind of periodical because that much of it was unintelligible to them?

The reason why those who understand algebra prefer it to arithmetic is that it is far simpler. A simple algebraic formula becomes so complex when written out in arithmetical language as to be difficult to understand, while a complex formula cannot be made intelligible in arithmetic. So true is this that those who understand algebra will not tolerate the use of arithmetic. They will not write in arithmetical language and the editors must decide whether such material, often of the most valuable character, shall be rejected because so little as six per cent. of it is resented by some of our readers.

It is easy to say "treat all subjects by plain arithmetic." It is just as easy to say keep warm in winter with summer clothing but it is another thing to do it. The trouble is that many of the problems connected with machine design cannot be treated by arithmetic while others would become so laboriously cumbersome if so treated that no one would read them, and least of all those who denounce "algebra."

Were we to admit nothing beyond arithmetic to our columns we must limit ourselves to subjects which are sufficiently simple to be treated by arithmetic and ignore others that are as strictly practical as any and lose our appeal to those who are interested in them.

There is no class of material that is so closely scrutinized in this office as the mathematical, the percentage of accepted material of that class being probably not over one-half of that of material in general. It is never accepted unless it says something worth saying and leads to some result worth knowing. The editors do their best to bring about the simplest possible treatment of every subject, mathematical articles being frequently simplified by them. If, sometimes, the treatment does not seem simple, the subject, and not the editors, must be blamed. We can only omit the mathematics by ignoring the subjects.

The other side of the case is that a mathematical student would scarcely admit that we use mathematics at all. Most of the articles that are classed as mathematical are not much more than symbolical arithmetic, letters being used in place of long descriptive names and signs for the words add, subtract, multiply and divide. We wish our objecting readers could be made to understand how elementary is ninety per cent. of the mathematics that we print, how little is required of them in learning how to read it and how infinitely plainer and simpler it is than the arithmetic which they think they want but which they would reject, not as they do algebra because they think it difficult, but in sheer weariness over the effort to understand involved, labored and cumbersome language.

"It is a condition not a theory that confronts us." It is too much to expect that the entire contents of a paper like ours, or like any other for that matter, shall interest every reader. The question which the editors have to answer in every case is: Will this article appeal to a sufficient number of our readers to justify its publication? It is for each reader to remember that he is not the only pebble on the beach. The reader who does not read mathematics has no more reason for resenting the small amount of mathematical work that we print than the shop man has for resenting the articles intended for the cost keeper or *vice versa.*

One does not need to eat all the things called for in a restaurant bill of fare in order to satisfy his hunger, or get his money's worth. It is our province to appeal to a circle of readers having widely varied, though related, tastes and interests. If each reader would remember this he would understand why we publish many articles that have no interest to him and he would also realize that many of the articles that interest him do not appeal to many others.

That mathematical articles are wanted is shown by their repeated appearance in the department of discussions, and by the fact that no typographical error can creep into them without its being pointed out, and usually by many readers.

New Publications

BRIQUETTING TESTS AT THE UNITED STATES FUEL-TESTING PLANT. By Charles L. Wright. 41 6x9-inch pages; 12 illustrations, numerous tables. Bulletin 385, United States Geological Survey, Washington, D. C.

This report covers the period from July, 1907, to January, 1908, during which interval 41 briquetting tests were made on 16 different kinds of coal using two kinds of binder, water-gas pitch and flour. The briquets were burned on war vessels, in locomotives and in kitchen stoves and grates. In addition to these combustion tests, physical tests were made to determine the strength and permanence of the briquets known as the "drop test," "tumbler test," "weathering test," "absorption test" and "density test." The report is well worth a careful reading by anyone interested in the manufacture or use of fuel briquets.

ELECTRIC MOTORS. By Norman G. Meade. 155 4½x7-inch pages; 126 illustrations; indexed. McGraw Publishing Company, New York City. Price $1 net.

In a simple style the author explains the phenomena of electric motors, describes the leading types of motors and associated appliances, and gives practical suggestions for their installation, care and up-keep. There are eight chapters with these headings: Theory of Electric Motors; Classification of Electric Motors; Control and Auxiliary Apparatus; Motor Generator Sets; Installation of Electric Motors; Operating Hints; Repairs; Tables and Formulas. The three chapters on installation, operating and repairs will be of especial service to the shop man who has motors under his care, and who desires a source of information to help him in this work.

PROCEEDINGS OF THE SIXTEENTH ANNUAL MEETING OF THE SOCIETY FOR THE PROMOTING OF ENGINEERING EDUCATION. Volume XVI. 409 6x9-inch pages; illustrated; indexed. Office of the Secretary, Pratt Institute, Brooklyn, N. Y.

As the papers presented at this meeting were duly reported and digested at the time of the meeting, it is only necessary by way of review to mention by titles some of the more important, to permit a reader to judge of the permanent value of the proceedings to him. Some of the papers are: The Function of the Engineer in the Conservation of Natural Resources: Courses in English in our Technical Schools; Result of an Experiment in Teaching Frenchmen English; A Proposed Course in General Engineering; Technical Instruction in Hydraulic Engineering; Cement Laboratory Practice; Careers of Graduates in Mechanical Engineering, and Should the Engineer be Required to hold License?

ON THE RATE OF FORMATION OF CARBON MONOXIDE IN GAS PRODUCERS. By J. K. Clement and L. H. Adams, with a mathematical appendix by C. N. Haskins. 46 6x9-inch pages; 8 illustrations. Bulletin 30 of the University of Illinois Engineering Experiment Station; Urbana, Ill.

The rate of formation of carbon monoxide from the reaction $CO_2 + C = 2CO$ was determined experimentally for three fuels; for charcoal within the temperature limits of 800 to 1100 degrees Centigrade; for coke between 900 and 1300 degrees; for anthracite coal between 1100 and 1300 degrees. A differential equation has been solved for the velocity of incomplete reactions, and from these investigations it is possible to compute the percentage of CO formed at any temperature and with any time of contact. For the production of a high percentage of CO gas the producer fuel bed should have a temperature of 1300 degrees Centigrade or over. Applying the conclusions to boiler practice a thin fuel bed will reduce the production of CO in the boiler furnace, and increasing the velocity of the gas will tend to decrease rather than increase the percentage of CO.

Annual Outing of the Worcester Branch of the National Metal Trades Association

The annual outing of the Worcester branch of the National Metal Trades Association was held at Edgemere, on Lake Quinsigamond, Worcester, Mass., on July 9. Members of the Boston, Fitchburg, Nashua and Worcester branches were invited and were escorted to the lake in automobiles where a genuine shore dinner awaited them. An exciting ball game between the Worcesters and visiting members, umpired by Samuel Winslow and two Harrington & Richardson pistols, resulted in a score of 6 to 4 in favor of the home team. This is largely due to the fact that the writer played on the visiting team. No one disputed a single decision of the umpire and his pistols and even the dryness of Worcester had no effect on the enthusiasm of the spectators.

Personals*

Benjamin Whittaker has resigned as treasurer of J. H. Williams & Co. to engage in the export business at 17 State street, New York City.

E. L. Mayall, who has been connected with the J. I. Case Plow Company, Racine, Wis., has become general superintendent of the Rock Island Plow Company, Rock Island, Ill.

Charles Ethan Davis becomes general manager of the Warner Gear Company, Muncie, Ind., effective August 1. Mr. Davis was formerly with the American Locomotive Company, Providence, R. I.

Henry W. Foster, formerly with A. P. Witteman & Co., of Philadelphia, has accepted a position with Henry Disston & Sons, Inc., Philadelphia, and will represent them in New England on their steels.

G. H. Shenberger, until recently in the drafting department of the Lehigh Coal and Navigation Company, has been appointed mechanical engineer with the Cast Thread Fitting and Foundry Company, Seneca Falls, N. Y.

Julius F. A. Vogt, for many years foreman of the die department of the Niagara Machine and Tool Company, Buffalo, N. Y., has resigned to accept the position of superintendent of the Lockport Stamping Company, Lockport, N. Y.

Carl A. Strom, mechanical engineer, in charge of the steam shovel and dredge department of the American Locomotive shops, Richmond, Va., has recently been transferred to the Roger works at Paterson, N. J., where he is acting in the capacity of manager.

Herbert V. Purman, formerly assistant superintendent of the National Manufacturing Company, Worcester, Mass., and more recently labor superintendent of the Corbin Motor Vehicle Corporation, has returned to Worcester as general foreman of the Heald Machine Company.

H. G. Nicholls, who has for several years been assistant general manager of the Canadian General Electric Company and the Canada Foundry Company, has resigned in order to go into business for himself in Toronto, Can., as Canadian selling agent for representative manufacturers.

F. A. Scott, for a number of years secretary of the Cleveland Chamber of Commerce and well known in the banking circles of that city, has accepted the position of secretary and treasurer of the Warner & Swasey Company. Mr. Scott is at present traveling in Europe and will take hold of his new work October 1.

Dr. Richard Moldenke, secretary of the American Foundrymen's Association, will attend the convention of the International Society for Testing Materials at Copenhagen from September 7 to 11. Doctor Moldenke leaves about the middle of August and will look after a variety of professional work in Germany and France before returning.

Williard P. Osborn, for the past nine years superintending engineer of Warren Webster & Co., Camden, N. J., previous to which connection he was designer of marine machinery with the New York Shipbuilding Company, has entered business for himself in Philadelphia in partnership with E. H. Robinson. They will engage upon power-plant engineering.

*Items for this column are solicited.

New Tools and Machine Shop Appliances

Showing New Ideas in Machine Shop Equipment That Make it Possible To Do Better Work at a Reduced Cost

THE LATEST INFORMATION

Sand Blast Nozzle That Does Not Wear Rapidly

One of the expenses and annoyances in connection with the use of the sand blast is the rapid wear on the nozzles. In the nozzle used in connection with the outfit shown herewith, this difficulty has been very largely overcome by using a construction as shown in Fig. 2, in which the air comes in at the side and, going through the annular jet around the pipe which supplies the sand, seems to keep a film of air between the sand and the nozzle, which effectually prevents undue wear.

FIG. 1. THE BUCKEYE SAND BLAST OUTFIT

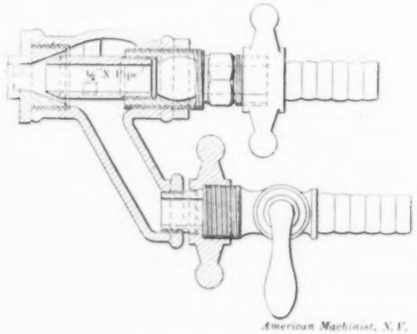


FIG. 2. DETAILS OF THE NOZZLE

This is a suction device, and one of the interesting features is the claim that the sand reservoir can be placed in the cellar, or any convenient point, and that the nozzle will elevate the sand to a point at least 50 feet above the tank. The sand flows from the tank into a sort of small hopper or collector at the bottom, which has an opening to the air at the back in such a way that a current of air is drawn in radially and seems to surround the sand during its passage through the hose, in this way protecting it very largely from the usual cutting action.

The tank is supplied with a rocking sieve, so that it can readily be kept filled with sifted sand, and there is said to be no difficulty of the sand clogging. This device is made in four sizes by Walter Macleod & Co., Cincinnati, Ohio.

A Light Portable Hydraulic Shear

There are many places (as for instance in boiler and bridge work) in which rivets or bolts must be cut off, but which are almost inaccessible to the ordinary bolt-cutter or saw, and inconvenient for the handling of a chisel—and in any case the latter process is apt to cause enlargement of the bolt holes or rivet holes, or do other damage. Where a heavy bolt cutter or a saw is used, two men are necessary to transport and use it. An improvement is offered in the hydraulic shear illustrated herewith, which has the further advantage that as it works without shock it does not loosen any nuts. Fig. 1 shows a

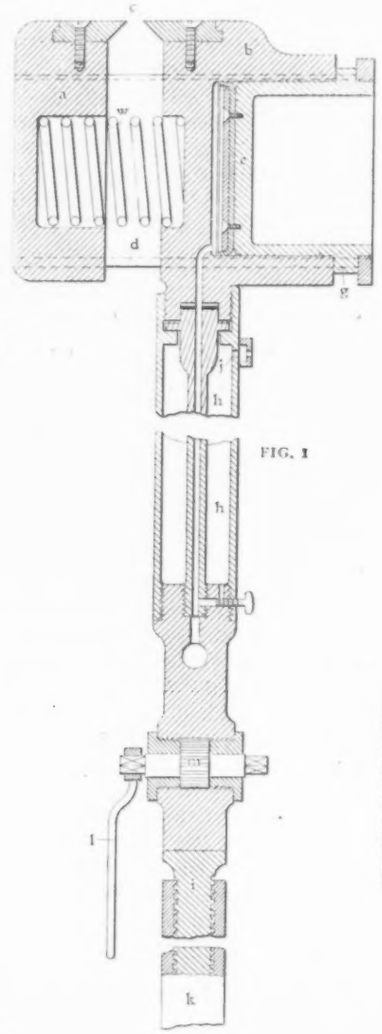


FIG. 1

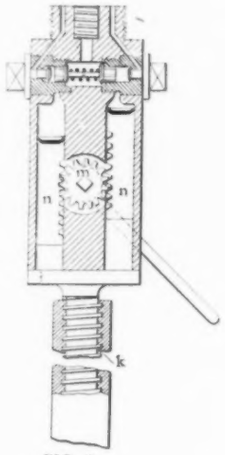


FIG. 2

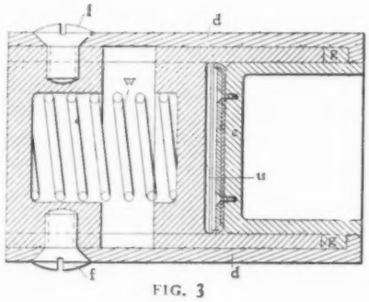


FIG. 3

American Machinist, N.Y.

LIGHT PORTABLE HYDRAULIC SHEAR

central lengthwise section, Fig. 2 a lengthwise section of the pump, and Fig. 3 a lengthwise section of the tool head. On the jaws *a* and *b* there are fastened the cutters *c*. The jaw *a* forms the main portion of the hollow piston-head *e*, which plays in the jaw *b* as its cylinder. The rods *d d* of the piston-head *e* play in dovetail grooves of the press-cylinder wall, and are fastened by the screws *f* to the head *a*. The lower surface of the grooves is arched, so that the movable jaw *a* is guided straight. A flange *g* of the press-piston *e* receives the rods *d d*, and limits the play of the cutters *c*.

The liquid reservoir *h* is in tight communication with the press cylinder *b*, and serves as handle for the tool. In connection therewith is the pump *i* which has a boss for a prolongation *k*. The pump *i* has twin pistons *n* driven by a pinion *m*, and hand lever *l*.

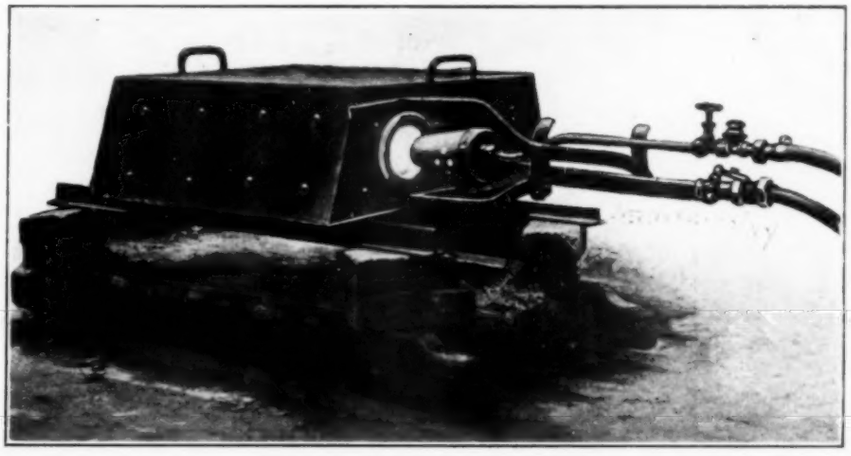
The inventor is Max Jensch of Bremen, Germany.

A Method of Drying Molds

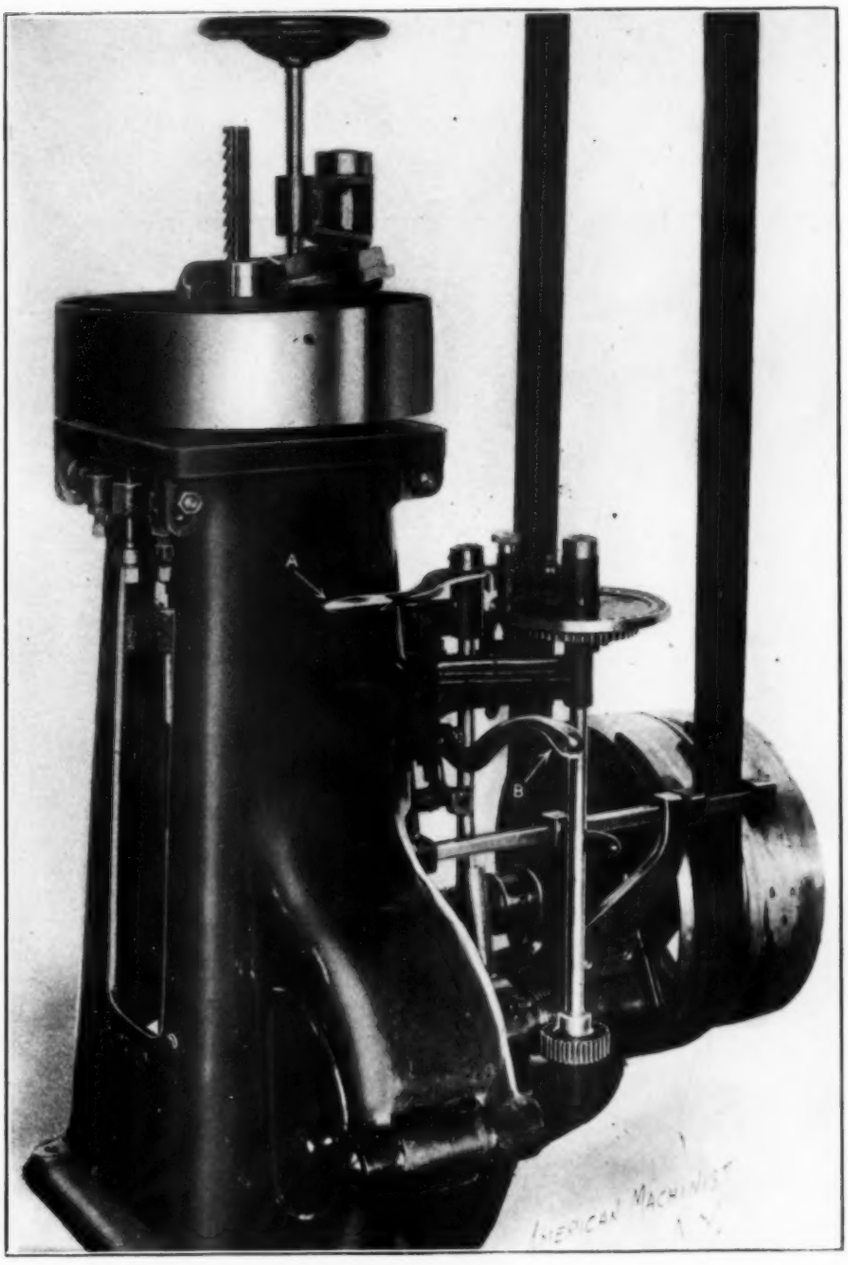
The accompanying illustration shows a portable burner in operation while skin drying or baking molds. Where the old burner is employed in baking molds it is frequently found inadvisable to apply the flame direct, and to overcome this difficulty a drying box, as shown, has been devised for use in connection with portable burners. This consists simply of a sheet-iron box fitted with handles for convenience in moving about the foundry. It is lined with asbestos sheeting and contains an opening at one end through which the flame enters from a burner fixed in a frame riveted to the box.

This box is placed over the mold, to which a clean uniform heat is reflected, and it can be reflected downward from 6 inches to 4 feet. In this way there is not only no ash deposited over the mold, as is the case with charcoal, but the waste heat is absolutely eliminated.

The apparatus described is the product of the Hauck Manufacturing Company of Brooklyn, N. Y.



BOX FOR DRYING MOLD WITH TORCH



LAPOINTE KEYSEATING MACHINE

Lapointe Keyseating Machine

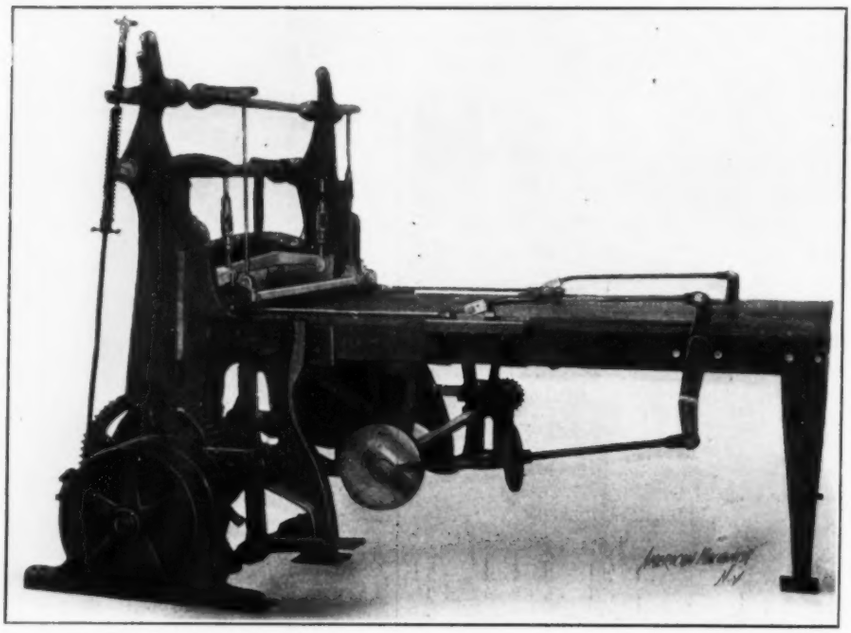
In operating this machine the feed is started by throwing lever *A* toward the machine, this bringing a roll on the other end out so as to be struck and thrown out by the index-pin arm when it reaches that point. In the meantime the depth of cut has been set by moving the index arm to the desired point, each hole representing 0.01 inch. The feed is taken from the worm below and operates on a wedge or key behind the cutter bar, forcing it out at every stroke. On the return stroke the wedge drops away from the cutter bar so as to allow it to return out of contact with the work, and prevent dulling its cutting edges.

The work is held on the table by the forked arm, which is loosely hinged at

the back, and is forced down by the screw and handwheel shown. The arm can be raised or lowered at the back to accommodate pulleys of variety width. The table can be flat for straight work, or tilted where the keyway is to be tapered. This is made by the Lapointe Machine Tool Company, Hudson, Mass.

Automatic Shearing Machine

This machine has been designed to automatically feed stock so that strips of any desired width, from 1/16 inch to 12 inches, may be automatically sheared from the long sheet. The feeding mechanism can be clearly seen at the side and is adjusted in much the same way as planer or shaper feeds. As soon as the sheet has been fed into position, a holding-down clamp, operated by the eccentric seen under the machine, holds the sheet firmly during the shearing operation. The action of the machine is very simple in every respect, and this mechanism can be applied to machines already in use. It is made by Bertsch & Co., Cambridge City, Ind.



AUTOMATIC MACHINE FOR CUTTING SHEET METAL

Universal Plate, Bar and Angle Shear

This machine covers a wide range of sheet-metal work, being equally well adapted for boilermakers and architectural or structural shops. It is always ready for any kind of work, and requires no changing, whether angle, plate or bar is to be cut. The view in Fig. 1 shows the plate shear at the front, while Fig. 2 gives a good idea of the location of both the angle shears, which allow right or left angles of even or uneven legs to be cut to any angle up to 45 degrees. The angle shears operate at an angle of 45 degrees, and can be used together or singly, according to the work in hand.

The clutch mechanism is designed without springs and is arranged to positively

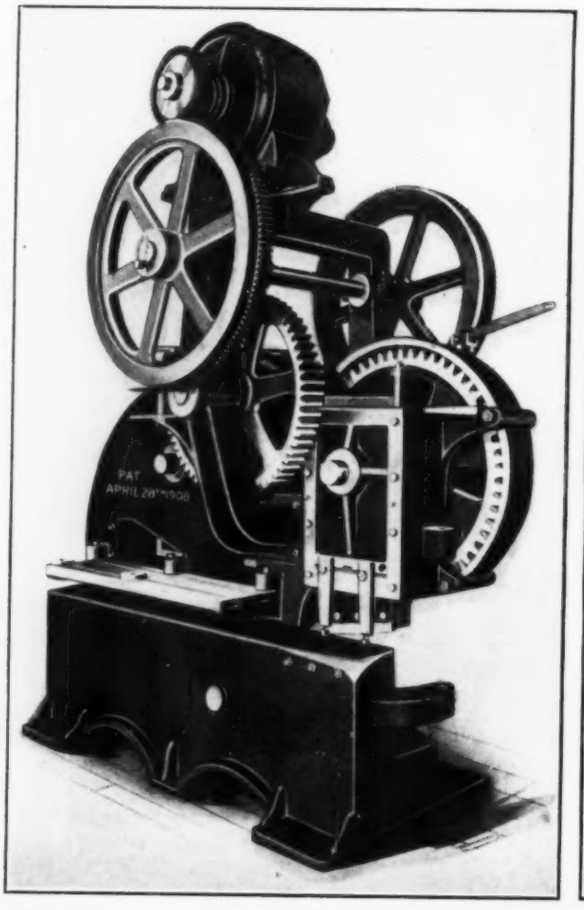


FIG. 1

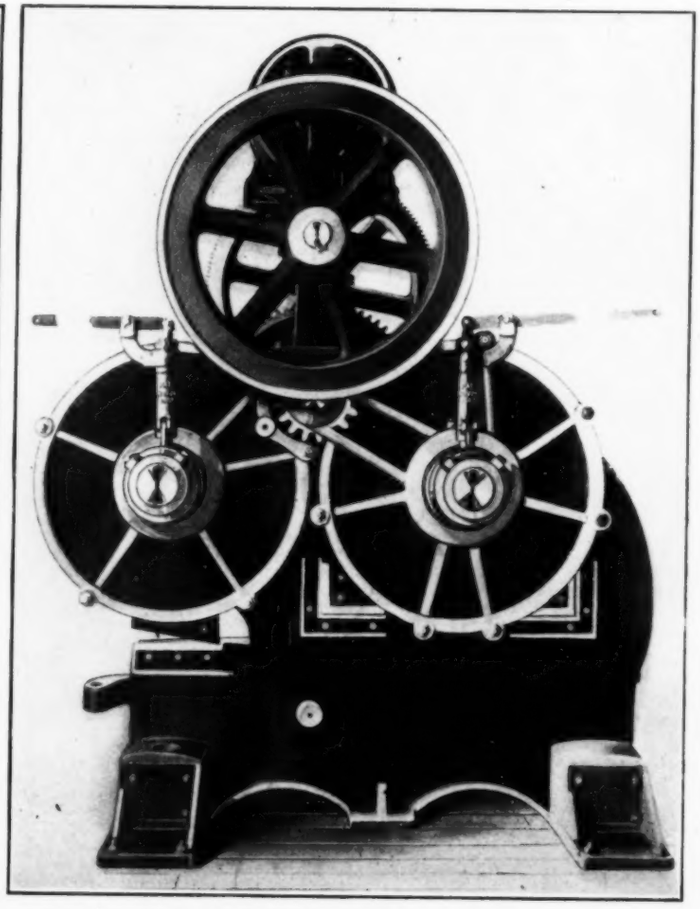


FIG. 2

FRONT AND SIDE VIEWS OF PLATE AND ANGLE SHEARS

op the knives at the highest point of e stroke. The clutch lever can be swung any position to suit the operator. All e knives are driven from one pulley or otor, are strongly geared and the gear vers, in addition to acting as guards, rm an outer bearing for the gears which, n turn, form a bearing for the eccentric haft. This gives a very stiff and compact achine, which can be built either for gle or double angles, and is furnished ith a turntable when desired. Each ouble-angle shear is provided with a table and gages for cutting different angles. This is so designed that it clears long sheets which are being cut by the plate shears. Bars may be cut in either the angle or plate shear. These machines are made in five sizes by the Covington Machine Company, Covington, Va.

The Ajax Wrench Attachment

The Ajax Wrench Company, Toledo, Ohio, is making an attachment for monkey wrenches which converts it into a pipe wrench with either smooth or serrated jaws for iron or brass pipe, and a variety of other uses. It appeals especially to the automobile operator, the garage or repair shops of any kind.

Trade Opportunities in Peru

By M. de Moreira

A record of 10 years of peace and sane and safe prosperity, and a healthy and remarkable increase in its commerce, entitles Peru to the earnest consideration of American manufacturers. The geographical location of Peru is apparently not well known by our manufacturers except for the bare fact that it is located in South America.

The republic of Peru is situated on the west coast of South America, approximately between 1 degree north and 19 degrees south of the equator, and between the 61st and 81st meridian, Greenwich time, the total area being 700,000 square miles. It is bounded on the north by the republics of Colombia and Ecuador; on the east by Brazil and Bolivia and on the south by Chile. The population is estimated at 3,000,000, and the principal cities are: Lima, Callao, Arequipa, Trujillo, Cuzco and Cajamarca.

The United States stands second in exports to Peru, and is also, next to England, the country which has the most enterprises there. The Cerro de Pasco railway, as well as its mines, are owned by New York capitalists; the Inca Rubber Company is also an American concern and probably the one that has spent the most money in the development of its plants.

New Docks and Steamship Lines

What Peru needs most to increase the wealth of the country is better means of communication, and the Government is doing its utmost to further this. Lately a national company was organized and has decided to build a fleet of thoroughly uptodate vessels capable of meeting the present and prospective demands of the coast traffic. The enterprise was organized under the name, "Peruvian Company of Steamers and Docks," the building of docks being one of its proposed enterprises. The company has also undertaken the construction of a floating drydock for the service of not only its own vessels but of others visiting the port of Callao.

In giving the order, Peru was sorry that it was not to American manufactures that it should go, but in the competition the price was against us, not that we could not compete with the English if we so desire, but because we place our profits at too high a figure. England, therefore, obtained the order to build a floating drydock capable of lifting a ship weighing 7000 tons in two hours. This serious step taken by the Peruvians to facilitate water communication will result in establishing many repair shops and also the purchase of machinery for future work in the port of Callao, and will permit American manufacturers to dispose of some machinery and machine tools.

A Railway for Opening Up Mineral Deposits

One of the most interesting and most important subjects for the development of Peru is undoubtedly the railway for the Chimbote Coal and Harbor Syndicate. This syndicate has also a mole under construction, owns extensive coalfields, and is prepared to fit up docks whenever the traffic warrants. The first section of the railway is 65 miles long and is just being completed. It will open up one of the richest and most populous districts in the country, from whence the products should find ready markets, not only on the coast but in the United States. In addition to the coal deposits, the route tapped by the Chimbote railway is rich in copper, silver and gold, and the opening of many mines is entirely dependent on its completion.

The extensive coalfields owned by the syndicate are now in process of development, it being the intention to accumulate large stocks of anthracite and bituminous coal pending the completion of the first section of the railroad in order to be in a position to begin making exports at the beginning of 1910.

Samples of this coal have been repeatedly tested and found satisfactory, and improved coal-mining and handling machinery will find there a good market, especially because coal has now to be imported into Peru, and the owners of the Peruvian coalfields see before them a great opportunity and realize the need of modern and labor-saving machines.

A Transcontinental Route

Another opportunity for manufacturers of railway machinery lies in the grant given by the government for building a railway, which will be not only the most important one of Peru, but may become one of the principal railways of the world. This line is to connect a port of northern Peru with a navigable point on the Maranhao (Amazon) river, in order to give an outlet to the west for the products of the Amazon region and form a direct route between the Pacific and the Atlantic oceans.

This railway can only be compared with those which exist across the continent in the United States, to the railway built by the Russians some years ago to Manchuria, or to the famous Cape-to-Cairo line, by which England desires to connect Egypt with the Cape of Good Hope. This new route across the South American continent will have an immense advantage over the other mentioned on account of being but 400 miles long, the rest of the route being formed by the Amazon river. Thus by this relatively short railway the two terminals, Paita on the Pacific and Para on the Atlantic coast, which are 3000 miles distant from each other, will be connected. The cost of the railway will be about $15,000,000, and work will, I understand, begin soon.

The starting point could not be better chosen, as the port of Paita is one of the best on the west coast and is situated just opposite the greatest depression of the Andes mountains. The engines will have to climb only 7000 feet, which is very little in comparison with the hight all other similar South American railways have to overcome.

The regions reached by this railway have, according to their altitude, different climates, some being cool, temperate and warm, and others dry and rainy, but all healthful and suitable for colonization.

Productiveness of the Country

The consequence of such differences of climate is that nearly all kinds of products can be found. On the highest altitudes exist natural pastures where cattle and sheep are raised. On the next lower, all American plants, vegetables and fruits grow the year round. On the plain of the Pacific side, cotton, rice, olives and semi-tropical fruits grow in abundance, and on the plains to the east of the Andes, coffee, cocoa and tobacco give very rich returns to the planters, but the richest of all products in that region is the rubber tree. All the rubber produced there has to be brought 3000 miles down the river to Para. Over the railway to be constructed the rubber will go to the west instead of, as now, to the east. This railway will, therefore, be a source of great wealth, not only to the natives, but also to manu-

facturers of various kinds of machinery, as without doubt new industries will start as the result of easy communication.

Petroleum

Another industry which ought to interest American manufacturers is that of petroleum. From an historical standpoint the discovery of petroleum in Peru is very interesting and dates from 1591, when Father Acosta recorded that the captain of the vessel on which he sailed to Peru had seen naphtha floating on the sea near Cabo Blanco. Later the Spanish crown conceded the petroliferous territory in Peru to Alonso Grandina. In 1826 the Peruvian government regained possession of the property and sold it to the Senor Quintana, who in turn transferred to Senor Lama and from that time, through sale or bequest, it passed into different

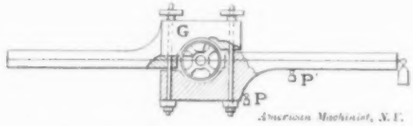


FIG. 1. ARRANGEMENT OF COMPENSATING BRAKE

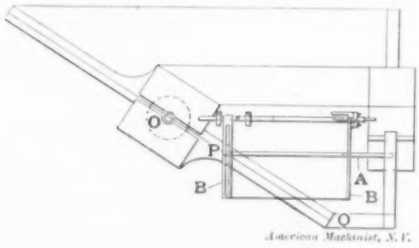


FIG. 2. ARRANGEMENT OF DIAGRAM DRAWING MECHANISM

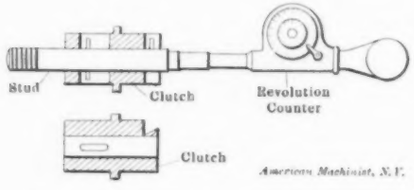


FIG. 3. ARRANGEMENT OF REVOLUTION COUNTER AND CLUTCH

hands until in 1888 it became the property of Dr. H. Weddle.

M. Lama also discovered petroleum in the neighborhood of Zorritos and formed a company in New York for its exploitation. The refinery in Zorritos is not equipped with modern machinery, and our machinery manufacturers have certainly great opportunity there, as the refinery is in the hands of men who are willing to do all in their power to augment their output. The same can be said of the refinery at Talara, which is similar to that of Zorritos, and which has two large and two small stills.

The opportunities for American manufacturers of machinery are, as it has probably been seen, not as large as in Chile, but they are numerous enough to induce them to study carefully a country which in a very short time will have as many, if not more, industries than its neighbor.

A Compensating Prony Brake*

The apparatus consists of a special form of prony brake which adjusts its torque automatically to the friction between itself and the pulley on the motor shaft. These adjustments are automatically recorded by a mechanism which traces a card or diagram from which it is possible to calculate accurately the average power delivered by the motor to the brake.

The torque for balancing a prony brake may be varied by adjusting the load on the end of the brake arm, or, keeping the load on the arm constant, by changing the effective length of the arm. The latter method was employed in the special brake developed by me. A brake was built as shown in Fig. 1, being made symmetrical about the axis of the motor shaft. The key was removed from the motor shaft so that the pulley was free to turn on the shaft. The brake was then clamped to the pulley and tested to see if it was properly balanced. This was done by means of a small weight just heavy enough to overcome the friction between the pulley and shaft. The weight was applied alternately at points equally distant and on opposite sides of the center of the pulley.

The brake was found to be slightly unbalanced, the center of gravity appearing to be somewhere near the point G, Fig. 1. By an adjustment of weights at the points P and P', an effective point was located, which balanced the center of gravity so that the brake was in equilibrium for all positions.

The recording mechanism for a brake which adjusts itself automatically by varying the effective arm, must record the horizontal component of the brake arm. The following scheme was employed to do this. A pin A, Fig. 2, was fastened to a convenient point P on the brake arm in line with the center O and the point where the load is applied. This pin engaged with a vertical slotted piece B, which was free to move only in a horizontal direction, and which was kept vertical by means of a guide (square section) sliding in bearings. This arrangement gives the guide a motion equal to the horizontal component of the pin's motion.

A pencil was fastened in this guide so that its point would press against the recording ribbon and thus record the horizontal displacement of the pin's motion, which when multiplied by the proper constant gives the horizontal displacement of the point Q.

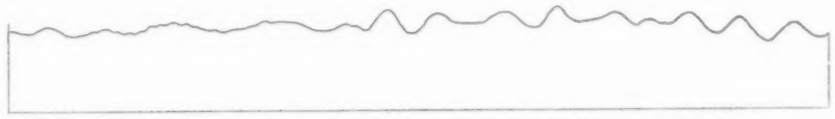


FIG. 4. Card No. 2. Mean ordinate = 1.92." Average effective arm = 33.065." Speed = 668 R.P.M. Load on arm = 12.58 lbs. H.P. = 4.4.

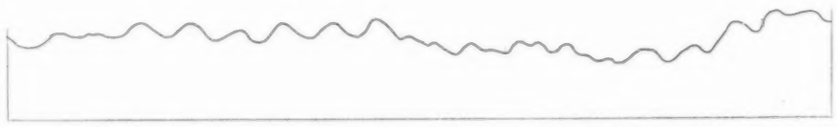


FIG. 5. Card No. 3. Mean ordinate = 1.93." Average effective arm = 33.09." Speed = 649 R.P.M. Load on arm = 24.87 lbs. H.P. = 8.47.

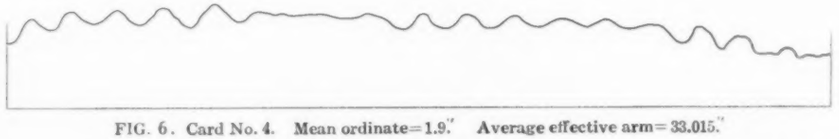


FIG. 6. Card No. 4. Mean ordinate = 1.9." Average effective arm = 33.015." Speed = 649 R.P.M. Load on arm = 24.87 lbs. H.P. = 8.46. American Machinist, N.Y.

The horizontal displacement of P was recorded by causing the pencil point to trace a line on a ribbon of paper, moving at right angles to the direction of the motion of the pencil. The ribbon was driven by two rollers such that its motion was proportional to the speed of the motor; *i.e.*, the ribbon traveled a certain distance for each revolution of the motor. This was accomplished in the following way.

A stud was screwed into the end of the motor shaft and connected to the spindle of a Starrett recording revolution counter through a positive acting clutch, as shown in Fig. 3. The dial of the revolution counter was connected to the feeding roll by means of a rod, as shown. When the clutch was thrown in, it drove the spindle of the revolution counter at the speed of

*Condensed from *The Sibley Journal of Engineering.*

the motor, and the dial of the counter drove the roll at 1/100 the speed of motor.

A stationary pencil point was adjusted to the moving pencil point so that it made a line on the ribbon corresponding to that which would be made by the recording pencil when the brake arm was in the lowest position that it was allowed to swing.

AS USED TO DETERMINE MOTOR EFFICIENCY

The efficiency of a motor is obtained by the following operation of the apparatus. The brake being properly balanced a weight (corresponding to the load desired) is put on the end of the brake arm and the brake is tightened up so that the brake arm takes a position somewhere between the extreme positions it is allowed to swing. A ribbon of paper is put between the rolls and readings of the revolution counter and integrating wattmeter are taken, then the clutch and wattmeter are thrown in at the same instant and after a certain period of time, say one minute, they are both thrown out, and the readings of the revolution counter and wattmeter are taken again. The wattmeter is thrown in and out by means of a switch connected in its shunt circuit.

The average or mean effective arm is found by multiplying the average value, obtained, on integrating the record on the ribbon, by the constant and adding this to the effective length of the arm for the lowest position. The revolutions per minute are computed from the revolution counter readings and the interval of time that the clutch is thrown in.

The mechanical output in horsepower is

$$H.P. = \frac{2\pi ndP}{33{,}000}$$

where

n = Revolutions per minute
d = Mean effective arm in feet
P = Load on arm in pounds.

The electrical input in horsepower may be found by the formula

$$E.H.P. = \frac{\text{watt hours} \times 60}{746 \times \text{time in minutes}}$$

$$\text{and } \frac{H.P.}{E.H.P.} = \text{efficiency}$$

Tests were made at the University of West Virginia on an 8-horsepower variable speed Stow motor at various loads and speeds.

Figs. 4, 5 and 6 are copies of typical cards and give an idea of the manner in which the friction between the brake and pulley varied.

The production of pig iron for the first half of 1909, as estimated by the reports of the furnaces, indicates the gradual recovery of the iron trade from the depression of last year. The total for the six months is 11,024,000 tons, which compares with 6,918,000 tons in the first half of 1908 and with 9,018,000 tons in the second half of last year.

Forging the Cutters for O. K. Tool Holders

BY P. H. ROBINSON

Many who attended the demonstration of the Firth-Sterling Steel Company, at Newark, were much surprised to see a tool-holder used in the powerful planer, working at the same depth of cut, feed and speeds as the solid forged tool.

In planing or turning heavy cuts, at high speed, there are several things to be taken into consideration.

FIG. 1. WORN CUTTER AND ITS CHIPS

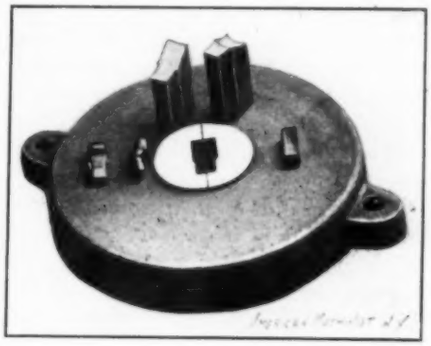


FIG. 2. DIE FOR FIRST FORGING OPERATION

The first is rigidity. In order to obtain the best results there should be absolutely no spring of the tool away from the work. Too much importance cannot be attached to this feature as it is a principle that is very important to obtain the maximum results from machines. Tools of the solid forged type were heretofore considered necessary, as all machine-tool builders aim to build their machines more powerful than the cutting tool.

Secondly, there must be a sufficient body of metal forged in the cutting point to rapidly soak up the heat generated by the friction of the chip against the cutting point. This friction on cast-iron work, fuses the metal to the top face of the cutting point. On steel, however, where the chips have more of a sliding action, the top face of the tool is worn away as shown in Fig. 1.

The friction of the chip has worn a hole in this cutter nearly 1/16 inch deep, but the wear has also taken place 1/16 inch back from the cutting edge. This seems peculiar but is explained by the fact that at the angle of shear the stock is crumpled and crushed and adheres to the tool protecting the edge, and the sliding action that curls the chip starts at a point back of the shear, or where the leverage is sufficient to start bending the chip.

Third, the tool must have the correct angles of clearance and top rake. The top rake must be such as will separate the chip from the body of metal in a manner to generate the least possible heat in proportion to the metal removed.

Lastly, the tool must be forged, hardened and tempered in the best possible manner, a thing which only long experience can teach.

The forging process used in making the O. K. tool holder cutting points, is the result of long experimenting in the handling of high-speed steels and is of a very interesting nature.

The first operation is the cutting up of the square stock into pieces that weigh exactly the same as the finished forging. This square billet is then heated, in a special furnace, of their own manufacture, to the proper forging heat and dropped into a hardened steel retaining die, upon a hardened steel punch that fits the profile of the die, both of which are shown in Fig. 2.

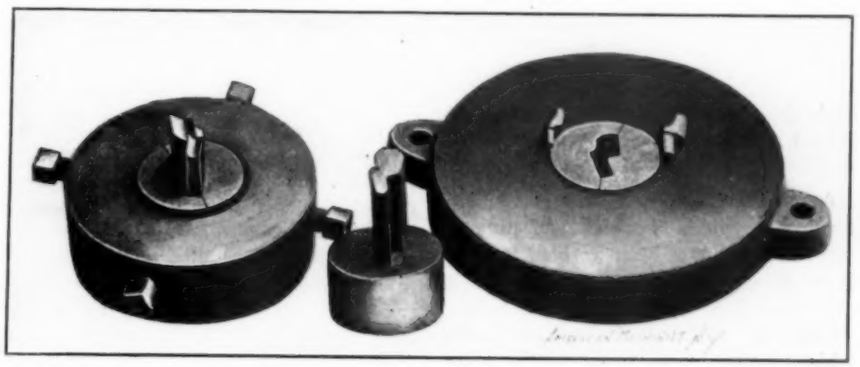


FIG. 3. PUNCHES AND DIE FOR LAST FORGING OPERATION

The top punch is then entered into the die and under a 50-ton pressure the square billet is blanked to the shape of the pieces shown laying on the left-hand side of the

die in Fig. 2. The top punch is then withdrawn and the blank raised, by the bottom punch, to a position on top of the retaining die, where it may be grasped by the tongs and removed to the furnace to be reheated.

It is next passed to another press and dropped edgewise into another retaining die having the profile of the finished forging, and the operation is repeated under 75-ton pressure. Fig. 3 shows the second retaining die, in its cast-iron plate, with the blank and finished forging lying on it. At the left is the top punch and holder and in the center the bottom punch and holder; the same type of holder being used on both blanking and finishing operations.

This method of forging cannot help but improve the grain of the steel. In all cutting points the steel is used with the cutting edge on the end of the grain. While this seems a small matter it has been

FIG. 4. CUTTER AND ITS CHIP

made the subject of careful study and has proved an advantage of no small importance.

Another commendable feature of their forging system is the high pressure exerted on the metal when forging the tool from the square to the finished shape in two blows, while the metal is confined within the walls of the retaining dies. This compresses the grain of the metal and is admitted by the makers of high-speed steels to be an ideal method of forging cutting points.

In Fig. 4 will be seen the high-speed steel cutter and a chip removed with it in the size *H* tool, when turning locomotive tires at the shops of the Market street elevated railroad in Philadelphia. This chip was taken at a speed of 12 feet per minute, with a 3/8-inch depth of cut and 7/16-inch feed, per revolution, on hard tire steel. All operations on the tire (5 in number) are performed by means of specially shaped tools, without disturbing the tool holder in the machine.

Automatic Suction-pipe Condenser for Steam-driven Pumps

By Gustaf Rennerfelt

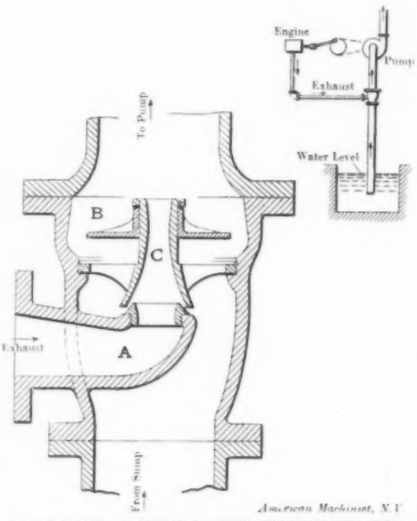
Many attempts have been made to dispose of the exhaust steam from a steam-driven pump by blowing it into the suction pipe of the pump. Some devices for such a purpose are on the market, notably for sinking pumps and mine pumps, and they operate with some degree of success.

These devices have not proved entirely satisfactory for the reason that they fail to handle the air which is always contained with the steam. If air is blown into the suction pipe of a pump its suction is apt to be lost, and the speed of the pump will be increased to a dangerous extent unless the steam supply is immediately cut off. In some of the coal mines in Pennsylvania automatic stopping devices are provided with old type suction pipe condensers, so that when the suction is lost by reason of air in the pipe the pump is automatically stopped. But the pump cannot be automatically started; it requires manual operation for priming the pump and for starting it again, and this is troublesome for the pump is generally located some distance away, and anyhow a mine operator always dislikes to have pumps stop on odd occasions.

The accompanying illustration shows an automatic condenser of the type in question so designed that advantage is taken of the kinetic energy of the exhaust steam to effect a compression of the air within the suction pipe so that the air is driven through the pump and into the delivery pipe. The pump is thus automatically reprimed whenever the suction is about to be lost, and all danger of the pump racing is obviated. This condenser is installed as a part of the suction pipe, and the steam exhaust is connected to the nozzle *A* (see the accompanying illustration). The valve *B*, which acts like a foot valve following the motion of the water, is arranged as shown with an injector tube *C* extending through the valve seat. The steam entering into the suction pipe becomes condensed by the water handled by the pump. The valve remains open as long as the suction is unimpaired, and no injector action takes place. As soon, however, as the suction is about to be lost by reason of an accumulation of air at the top of the suction pipe the valve will close. Injector action will then occur, so that water from the sump will be drawn by the steam through the injector tube, causing compression of the air so that it is driven through the pump and its delivery pipe. The suction is then restored to the pump, so that the foot valve opens and remains open until a certain amount of air is again collected at the upper end of the suction pipe when the same performance is again repeated.

This device is thus entirely automatic, and it is operative up to a considerable hight of lift depending, of course, on the temperature of the water and the ratio between the amount of steam used and the amount of water delivered by the pump. If the condenser be located higher than the level of the sump a vacuum is given for the exhaust, the degree of vacuum being in direct proportion to the hight of the steam nozzle above the surface of the sump. While such a vacuum is, of course, desirable, the main object is to dispose of the exhaust together with the air contained therein, and this object is accomplished nicely by utilizing a part of the energy of the steam for compressing the air.

It is not customary or practicable to install for all pumps high-priced condensers giving a high vacuum because, aside from the question of price, such condensers are complicated and require more attendance than can be given to



AUTOMATIC SUCTION PIPE CONDENSER FOR STEAM-DRIVEN PUMP

them. It is more customary to exhaust the steam below the surface of the sump, sometimes as deep as 8 feet. This causes a corresponding back pressure, which, however, is a small drawback compared with other disadvantages, such as vitiating of the atmosphere and rotting of timbers.

It would, therefore, appear that this automatic suction-pipe condenser for pumps—although it cannot give a high vacuum—will by reason of its simplicity and low cost fill a long felt want.

In discussing before the Engineers' Society of Western Pennsylvania, the promising field for the steel oil derrick, R. B. Woodworth made mention of the fact that the total of wells drilled in 1907 in the United States for oil and gas was 22,765, apart from which there was a large number of salt wells, artesian wells and other bores of great depth that made the year a notable one in deep drilling.

Business Items

For some time past a part of the general offices of the Whitman & Barnes Manufacturing Company have been in Chicago and a part in Akron, Ohio. In order to give better service it has been decided to locate the general offices in Akron.

The Garwood Electric Company has appointed the International Supply and Export Company, Bank of Commerce building, St. Louis, Mo., as its sales agent in Missouri, Kansas, Oklahoma, Texas, Louisiana, Arkansas, Mississippi, that portion of Tennessee and Kentucky within 70 miles of the Mississippi river, and all of Illinois within 70 miles of St. Louis.

The condition of improvement which the Westinghouse companies find their business has undergone during the past month, maintain the same steady rate of advance already noted during the previous months of the present year, assuring, before the close of 1909, a repitition of the busy times of 1907. The Westinghouse Air Brake Company, Wilmerding, Penn., has received a large number of orders for brake apparatus and friction draft gear. As an index of the improved conditions at the Union Switch and Signal Company, Swissvale, Penn., this plant is now employing about twice the number of men of a year ago. In June, the Westinghouse Electric and Manufacturing Company, East Pittsburg, Penn., enjoyed an improvement of 25 per cent. over its business of May. Switchboards and auxiliary supplies, amounting approximately to $500,000, have been ordered by the Pennsylvania Tunnel and Terminal Company for the New York terminals and tunnels of the Pennsylvania Railroad. In line with the encouraging improvement noted by the Westinghouse Machine Company the Philadelphia Rapid Transit Company has recently placed orders for two steam-turbine equipments, of 6,000 and 12,000 kilowatts capacity respectively.

Business Opportunities

S. R. Horne, Morrisville, N. C., will establish a hosiery mill.

Frielink & Bremmel, Wausau, Wis., will establish a candy factory.

William Schaefer, St. Louis, Mo., carriage builder, will erect a new factory.

The Kilby Locomotive and Machine Works, Anniston, Ala., will enlarge its plant.

The Cleveland (Ohio) Worsted Mills Company will erect a new $80,000 building.

The Warren Leather Goods Company, Worcester, Mass., will erect a new building.

The Jones & La Borde Boat Works, at Oshkosh, Wis., was partly destroyed by fire.

The Eng & Orr Foundry Company, Denver, Colo., has bought a site for a new foundry.

The Olds Gas Power Company, Lansing, Mich., will erect an addition to its foundry.

The Vulcan Iron Works, Denver, Colo., is erecting new machine and blacksmith shops.

The Kleckhefer Box Company, Milwaukee, Wis., is rebuilding their plant recently burnt.

Brown Bros. & Co., Gardner, Mass., chair manufacturers, will build an addition to plant.

The Byron Weston Company, Dalton, Mass., will build a three-story addition to paper mill.

The Minneapolis & St. Louis Railroad will spend $100,000 in enlarging shops at Cedar Lake.

The Richlieu Knitting Company is erecting a four-story addition to plant in East Utica, N. Y.

The shingle mill of the Wisconsin Bark and Lumber Company, Antigo, Wis., was destroyed by fire.

Chas. E. Rogers, Jr., 112 Wall street, New York, is rebuilding sawmill in Brooklyn recently burned.

R. W. Rhodes & Co., Long Island City, N. Y., will build a three-story addition to metalline factory.

The box factory of Knauer Bros., Jacksonville, Fla., was destroyed by fire. Loss, about $10,000.

The Phillips & Buttorf Company, Nashville, Tenn., contemplates the erection of another foundry.

New addition to Block I shops of the Grand Trunk Railway at Port Huron, Mich., will soon be built.

The Consolidated Safety Pin Company, Bloomfield, N. J., will erect additions to two of its buildings.

The Corbin Screw Corporation, New Britain, Conn., has had plans prepared for a large addition to plant.

The Montague Mailing Machine Company, Chattanooga, Tenn., will erect two-story addition to plant.

The plant of the Diamond Lumber Company, Green Bay, Wis., was destroyed by fire. Loss, $100,000.

The Wisconsin Thread Company, of Chicago, Ill., will locate in Elgin, Ill., where a new plant will be erected.

It is reported that the Diamond Iron Works, Ltd., Hammond, La., contemplates establishing an iron foundry.

Fire destroyed the cut-up mill of the Oxford Paper Company at Rumford, Me., causing a loss of $100,000.

The Pittsburg (Penn.) White Metal Company has awarded a contract for the erection of a new factoty building.

The New York Central Railroad has completed plans for machine shop and blacksmith shop at Lyons, N. Y.

The De Soto Foundry and Machine Company, Mansfield, La., will build a plant for manufacturing Tropenas steel.

The Spaulding Manufacturing Company, Grinnell, Iowa, may enlarge its plant for the manufacture of automobiles.

The W. Eddy Plow Company, Greenwich, N. Y., expect to build a new factory to increase the output of the plant.

The Richard French Iron Works, Worcester, Mass., manufacturing builders' iron work, has purchased site for a new plant.

The J. F. McMillan Company, Minneapolis, Minn., has taken out a permit for an $80,000 addition to its packing plant.

The Peerless Motor Car Company, Cleveland, Ohio, has taken out a permit for the erection of a $30,000 factory building.

The plant of the Termaat & Monahan Company, Oshkosh, Wis., manufacturing gasolene engines, was partly destroyed by fire.

The Peck Manufacturing Company, Warrenton, N. C., recently organized, will erect mill for the manufacture of cotton yarns.

Plans are being prepared for a four-story addition to the machine plant of the Schütte & Koerting Company, Philadelphia, Pa.

The United States Steel Carporation has decided to construct a 50-mill tin plate plant and a 50-mill sheet steel plant at Gary, Ind.

The J. L. Lehman Company, of Lancaster, Penn., will establish a branch plant in Beaumont, Texas, for the manufacture of woodenware.

William F. Marresford, 56 Pearl street, Brooklyn, N. Y., is in the market for second-hand milling machine in good condition.

The Boston & Albany Railroad is to build a new modern roundhouse in South Framingham, Mass., to replace present wooden engine house.

The Compania Industrial de Guadalajara is to replace cotton mill at Guadalajara, Mexico, recently burned. New mill will cost $500,000.

The Toledo (Ohio) Motor Company, successor to the Pope Motor Car Company, is overhauling its plant and will probably need a new equipment.

The Coralina Paper Pulp Company, Newbern, N. C., is planning improvements to cost $350,000. Three new buildings will be erected.

The W. F. Norman Sheet Metal Manufacturing Company, Nevada, Mo., will build an addition which will double the capacity of its plant.

The Reliance Motor Truck Company, Owosso, Mich., will build additions to its plant, which will make it about five times as large as it is at present.

The Shull Steel Casting and Manufacturing Company, Canton, Ohio, is erecting an addition to plant which will provide more space for foundry.

Plans and specifications are on file at the Chamber of Commerce, Jackson, Mich., for new factory for the American Gear and Manufacturing Company.

The Richards Manufacturing Company, Aurora, Ill., is making plans for an addition to its plant. The company manufactures hardware specialties.

The International Lead Company, of New York, is erecting a factory in Bayonne, N. J., for the manufacture of lead pipe and other lead goods.

The Brecht Bros. Butchers Supply Company, Denver, Colo., will erect a new five-story building for the manufacture of butchers' implements and supplies.

The Stevens & Thompson Paper Company, Middle Falls, N. Y., contemplate building an addition to mill and develop the water power on the property.

The Ford Automobile Company, Detroit, Mich., has erected a new building to be used for assembling and storage. The company will also erect a power house.

The Seagrave Company, of South Columbus, Ohio, contemplates erecting an addition to its plant. The company manufactures fire-fighting apparatus.

The Dahlquist Manufacturing Company, South Boston, Mass., will be in the market for modern equipment for a new factory for the manufacture of copper range boilers.

The roundhouse of the Northern Pacific Company, at Jamestown, N. D., partly destroyed by tornado some time ago, is to be rebuilt. About $60,000 will be spent.

The Wheeling (W. Va.) Mold and Foundry Company has closed a contract for the erection of a 25-ton steel casting furnace, and will also install brass cutting machinery.

New Incorporations

The Quachita Power Company, Little Rock, Ark., has been incorporated with $50,000 capital.

The Safety Wrench Manufacturing Company, New London, Conn., has been incorporated Thomas F. Foran, president and treasurer.

The Syracuse Chilled Die Company, Syracuse, N. Y., has been incorporated to manufacture dies. Capital, $10,000. Incorporators, E. P. Schram, Arthur Sjohim, J. F. Ullman.

The Alexandria Repress Brick Machine Company, Alexandria, Va., has been incorporated to manufacture brick machinery. Capital, $25,000. President, E. L. Cockrell, Woodbridge, Va.

The Ontario Pump Manufacturing Company, Rochester, N. Y., has been incorporated to manufacture pumps. Capital, $10,000. Incorporators, T. T. Grasser, R. R. Stitch, W. S. Hall and others.

Bogart Gas Power Engineering Company, Buffalo, N. Y., has been incorporated to manufacture gas engines, motors, etc. Capital,

$25,000. Incorporators, S. Ginsburg, J. A. Venable, etc.

The Standard Typewriter Company, Groton, N. Y., has been incorporated to manufacture typewriters. Capital, $1,000,000. Incorporators, C. B. Brown, Hoosick; E. J. Forhan, J. J. Harper, Groton.

The Metz Automobile Company, Paterson, N. J., has been incorporated to manufacture automobiles, motorboats, engines, etc. Capital, $25,000. Incorporators, J. M. B. Ward, S. F. Holden, P. J. McGinnis.

The Bolte Manufacturing Company, Kearney, Neb., has been incorporated to manufacture cement mixers and block machines. Capital, $50,000. Incorporators, T. H. Bolte, D. Wort, J. S. Minton, D. H. Miller.

The Greenfield Paper Bottle Company, Jersey City, N. J., has been incorporated to manufacture paper, paper bottles, etc. Capital, $1,100,000. Incorporators, E. T. Greenfield, E. H. Johnson, J. R. Turner.

The Acme Column Company, Jersey City, N. J., has been incorporated to manufacture fireproof columns, iron, steel, etc. Capital, $50,000. Incorporators, J. J. Tresidder, E. Naumann, G. D. Benham, Brooklyn, N. Y.

Anderson Winding Machine Company, Jersey City, N. J., has been incorporated. Capital, $50,000. Incorporators, H. Sutcliffe, W. O'Connor, C. E. Fisk. The company will manufacture electric magnets, motors, dynamos, etc.

Abell Equipment Manufacturing Company, Chicago, Ill., has been incorporated to conduct a general machine shop, foundry, car building and manufacturing business. Capital, $35,000. Incorporators, O. J. Abell, E. M. Sweet, F. W. Sweet.

New Catalogs

Halcomb Steel Company, Syracuse, N. Y. Catalog and Hints on Steel. Illustrated, 78 pages, 4x6 inches, cloth.

Graham Nut Company, Pittsburg, Penn. Catalog of nuts, bolts, washers, rivets, etc. Illustrated, 76 pages, 4x6 inches, paper.

The Ajax Wrench Company, 2 Bridge street, Toledo, Ohio. Catalog of Ajax wrench. Illustrated, 14 pages, 3½x6 inches, paper.

F. C. Sanford Manufacturing Company, Bridgeport, Conn. Folder illustrating and describing portable oxy-acetylene welding machine.

The Linde Air Products Company, Buffalo, N. Y. Catalog describing Fouche oxy-acetylene blow pipe, etc. Illustrated, 34 pages, 6x9 inches, paper.

Grant-Hoover Ball Company, Merchantville, N. J. Catalog and price list of steel, brass, bronze and cast-iron balls. 8 pages, 3½x6 inches.

National Brake and Clutch Company, 16 State street, Boston, Mass. Pamphlet showing recent applications of cork inserts. 34 pages, 6x9 inches.

The Triumph Electric Company, Cincinnati, Ohio. Bulletin No. 361, describing induction motors in a piano factory. Illustrated, 8 pages, 7x10 inches.

J. H. Williams & Co., Brooklyn, N. Y. Catalog of iron, steel, copper, bronze and aluminum drop forgings. Illustrated, 120 pages, 6x9 inches, paper.

American Steam Gauge and Valve Manufacturing Company, 208 Camden street, Boston, Mass. Circulars descriptive of positive water glass guard. Illustrated.

The G. M. Yost Manufacturing Company, Meadville, Penn. Catalog of various types, vises, wrench, electric bulb holder. Illustrated, 24 pages, 5x6½ inches, paper.

Westinghouse Electric and Manufacturing Company, Pittsburg, Penn. Booklet describing application of small motors to office, store and shop service. Illustrated, 3½x6 inches.

Wickes Bros., Saginaw, Mich. Catalog A, describing vertical and horizontal plate bending rolls, punches, shears, riveting machines, flanging presses, etc. Illustrated, 40 pages, 9x12 inches, paper.

The International Acheson Graphite Company, Niagara Falls, N. Y. Folder No. 295C describing electrodes, dry battery filler, paint pigment, graphite for lead pencils, general lubrication, graphited greases, etc.

The Electric Controller and Manufacturing Company, Cleveland, Ohio. Booklet entitled "Electric Motor Control," being a series of five articles by A. G. Eastwood, president of the concern. Illustrated, 4½x6½ inches, paper.

Hess-Bright Manufacturing Company, Philadelphia, Penn. Sheet No. 37, Series 336, illustrating and describing drill press spindle thrust ball-bearing mounting and Sheet 38, Series 336, describing cranehook thrust ball-bearing mounting.

Want Advertisements

Rate 25 cents per line for each insertion. About six words make a line. No advertisements abbreviated. Copy should be sent to reach us not later than Friday for ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded, they will be destroyed without notice. No information given by us regarding any advertiser using box number. Original letters of recommendation or other papers of value should not be inclosed to unknown correspondents. Only bona-fide advertisements inserted under this heading. No advertising accepted from any agency, association or individual charging a fee for "registration," or a commission on wages of successful applicants for situations.

Miscellaneous Wants

Caliper list free. E. G. Smith, Columbia, Pa.

We buy or pay royalty for good patented machine or tool. Box 282, AMER. MACH.

Hand power bending tools, labor-saving, money-making. Estep & Dolan, Sandwich, Ill.

Light, fine machinery to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

Wanted—Seven-inch screw-cutting lathe in good order. McKay, 153 East Fifty-third street, New York City.

A large foundry and machine shop desires to add to present lines of manufacture. Box 126, AMERICAN MACHINIST.

Machines designed; automatic special. Practical working drawings. C. W. Pitman, 3519 Frankford Ave., Philadelphia, Pa.

Special machinery accurately built. Screw machine or turret lathe work solicited. Robert J. Emory & Co., Newark, N. J.

Light and medium weight machinery and duplicate parts built to order; tools, jigs, etc. MacCordy Mfg. Co., Amsterdam, N. Y.

Wanted—A cutter grinding machine, No. 2 or 3 Brown & Sharpe preferred. McKay, 153 East Fifty-thrd street, New York City.

We design and build all kinds of light machinery, including dies, fixtures, tools and model work. The Matson Machine Co., Bethel, Vermont.

Wanted—Designs and prices of machines for tapping iron pipe fittings two to six inch. Box 126, AMERICAN MACHINIST.

Metal specialties manufactured; models, dies and special machinery. Inventions perfected; correspondence solicited. W. E. Villinger, Williamsport, Pa.

Am in market for a machine for coiling copper pipe of various sizes, say five-inch coil of three-quarter inch pipe, number eighteen gage. James W. See, Hamilton, Ohio.

I have an unusually good proposition. Wish to connect with firm desiring additional line of manufacture. Would consider organization of new company. Box 387, AM. MA.

Purchaser for No. 2 Farwell milling machine, Grant hobbing machine and Gisholt tool grinder; all practiacly new and in A-1 condition. Box 408, AMERICAN MACHINIST.

Wanted—To sell or negotiate machine patents, patterns, etc.; big market and good profit; highest possible indorsements; $10,000 to $25,000 backing required. "Builder," 808 N. C. Ave., Washington, D. C.

A large English firm of machine-tool importers having showrooms and offices in Great Britain, France, Italy and Japan, is wanting good agencies for machine tools of all kinds. Apply Box 189, AMERICAN MACHINIST.

Wanted—Machinery to build (special line for Canada) or would build on royalty, or would consider manufacturing proposition. Have general machine shop equipment and exceptionally low costs. Box 424, AMERICAN MACHINIST.

A large well equipped machine shop on the south side of Chicago would like some work outside of its regular line; factory is equipped to do small and moderately heavy work; also experimental work; has good railroad facilities. Box 428, AMER. MACHINIST.

Situations Wanted

Classification indicatss present address of advertiser, nothing else.

CANADA

Wanted—A position as toolroom foreman; 20 years' experience, chiefly on fine work, subpress dies, jigs, gauges, etc. Will be at liberty 15th August. Box 418, AMERICAN MACHINIST.

CONNECTICUT

Practical mechanic; broad experience as general foreman, on general jobbing and construction work, good executive ability; best of references; will go anywhere, middle west preferred. Box 400, AMERICAN MACHINIST.

DELAWARE

Mechanical draftsman, experienced mostly on machine tools, wishes to change. Box 338, AMERICAN MACHINIST.

ILLINOIS

Superintendent of old and well known machine shop in Chicago is seeking change; age 44; good reference. Box 429, AMER. MACH.

Machine designer with 20 years' experience on machine tools, sheet-metal working machines and dies, and on tools, jigs and fixtures, wants work. Box 432, AMER. MACH.

Wanted—Position as superintendent by a man experienced in modern machine shop and foundry practice; a good organizer and executive who can increase output and reduce costs. Address Box 435, AMER. MACH.

INDIANA

A natural born mechanic and foreman, A-1 machinist and diemaker, expert on punch presses, successful organizer, also in handling men, at present holding a responsible position with good recommend, open for engagement in two weeks; good foreman position will be accepted; married man, age 29. Address M. N., P. O. Box 61, So. Whitley, Ind.

MASSACHUSETTS

Position by assistant superintendent, thoroughly experienced in machine shop practice, tool design and modern manufacturing methods; practical, systematic and successful manager of men; age 38; married. Address Box 431, AMERICAN MACHINIST.

MISSOURI

Superintendent or foreman on light or medium interchangeable work; up-to-date on latest shop methods and system of cost keeping; good manager of help, practical mechanic or designer. Address Box 422, AMER. MACHINIST.

NEW JERSEY

Mechanical engineer, graduate, with several years' experience in general machinery, gas engines, automobiles and pumping machinery, desires responsible position. Age 28. Box 390, AMERICAN MACHINIST.

Position as superintendent or general foreman on interchangeable work; 20 years' experience; competent to take charge of designing tools, jigs and fixtures for drilling, milling and grinding, caming automatic screw machines and press work successful in organizing and handling help; age 38; A-1 reference. Box 436, AMERICAN MACHINIST.

Productive engineer desires to make change; up-to-date on high-speed steel, speeds and feeds; understands piece work and prem-

Gages Used in Making Comptometers

Gages for Alining Assembled Machine and Testing Accuracy of Machine Work on Levers, Rods, Cams, Gears, Pawls, Etc., also Thickness of Metal

EDITORIAL CORRESPONDENCE

The comptometer, which is an adding machine made by the Felt & Tarrant Manufacturing Company, Chicago, Ill., is made so that all the parts are interchangeable, and any of the parts in any column of the machine can be changed in from to size in order to make each figure register correctly, as well as to carry from one column to the other when 10 has been reached. When the total is obtained a lever is pulled that cancels the whole thing and places all the columns back at 0, so

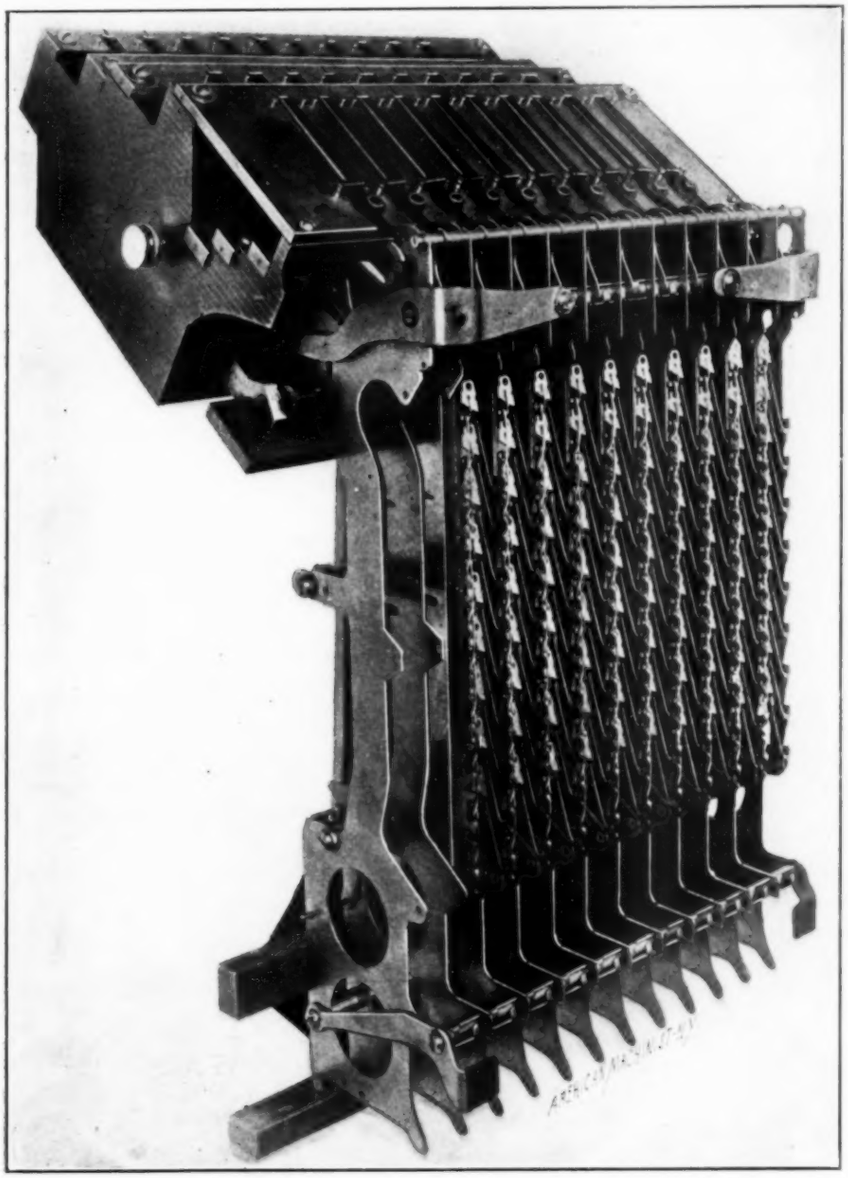


FIG. 1. GAGING DIFFERENT PARTS OF ASSEMBLED FRAME

10 to 15 seconds, and the machine will work perfectly without any adjustment thereafter.

The numerous parts which enter into the construction of the machine are small, and each part must be machined exactly that it can start adding another set of figures.

The machine is built with different numbers of columns; thus, an eight-column machine will add sums up to one unit less than 100,000,000; a ten-column machine will add sums up to one unit less than 10,000,000,000, and so on. The parts which enter into the construction of one column are the same as the parts which go to make up any other column, therefore, to make different sizes of machines really means the adding of duplicate columns and having a case big enough and rods long enough to fit.

To build this machine requires first-class material, so it will wear well, and very fine work in machining the different parts, so it will be accurate. When the parts have been machined it requires numerous gages to check up the work and see that the different parts are exact in size and shape. For that reason the gages are one of the most important things in the manufacture of this machine, and the toolmaking department is, therefore, an important part of the shop.

Frame Gage

The largest gage that is used is shown in Figs. 1 and 2. This is really a combination of gages, as it is made to gage four different places on each column of a 10-column machine. The same gage is used for gaging smaller machines, and when an eight-column machine is gaged it merely means that the two or three levers at one side do not touch anything, and, consequently, remain idle.

There are four banks of 10 levers each on the gage, making 40 places on a 10-column machine that are gaged after the frame has been assembled. There is a line scribed on the center of the end of each lever and a corresponding line on the plates on which the levers rest. These two lines must come exactly together before the assembled frame can be passed on for further operations. The levers are multiples of 6 to 1, therefore any error in the machine is magnified, at the end of the lever, to six times its actual size, and as the scribed lines on the lever and plate must come in perfect alinement, the exactness of the work can be appreciated.

The completed comptometer with the case off is shown in Fig. 3, so as to give an idea of the number of parts in it, their size, and the work which each has to do.

Gaging Frame Side

The frame side, one of which goes in each column, is shown in Fig. 4, after it has been repunched. As will be seen, there are numerous small holes in it and these have all been put in with a punch press. After the frame side has been re-

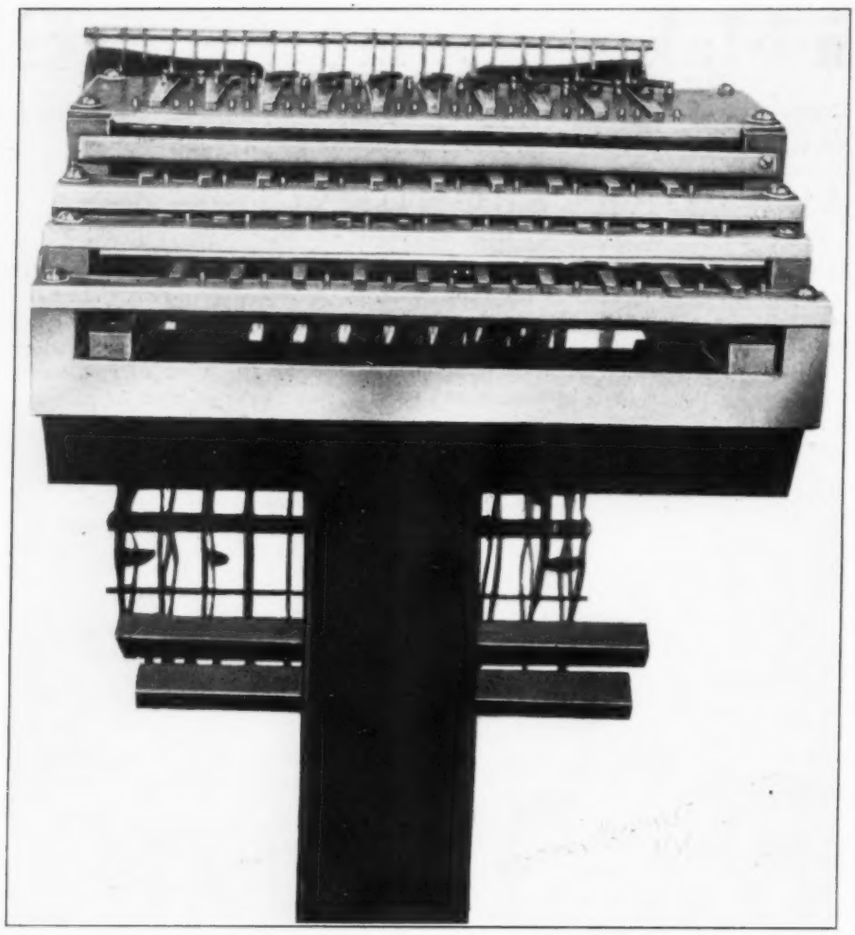


FIG. 2. FRAME GAGE AS IT STANDS ON PEDESTAL

punched it must fit over the 18 square-topped or sharp-cornered pins which are in the gage plate, as shown in the cut. The holes must fit the pins exactly, and the piece must go on without any undue pressure being brought to bear, or without any of the holes being sheared by the pins, which are hardened. This proves that it has been punched exactly to size and shape.

The thickness of metal in this frame side must also be exact, as when 10 of them are used in the 10-column machine it would throw the whole machine out of alinement if they were not. The company, therefore, pays a big price for its steel plate, but for this it insists on unusual accuracy, as the variation of 0.001 inch in the thickness of each frame would make 10 of them off 0.010, and, therefore, the other parts would not work correctly.

Gaging the Segment Lever

In Fig. 5 is seen the segment lever as it is being gaged. This gage is used in various ways. It is first used in the punch-press department, when repunching the holes, as the repunching must be so accurate that the two little arms *A A* will just touch the bumps on the lever, and not move the spring lever *D*, which holds the segment in position, it being located at the end to the left by a pin. Lever *B* must also just pass and touch the segment lever when the arms *A A* are touching the bumps, as shown.

It is next used after milling the teeth, on the end. The segment is held in position by the spring lever *D* pressing it against the two arms *A A*. The gear tooth shaped point on the lever *C* must then just fit between two teeth without moving the spring lever *D*.

The third place in which it is used, is for gaging the play of the lever. For this the gear and pointer *E* is put on the gage plate, the arms *A A* and *B* thrown out of the way, and when the lever is moved to its highest point, the pointer must come between the two lines shown at its end. When the segment lever is moved to its lowest point, the pointer must come between the two lines shown at the lower end of the small spring on lever *C*. This insures that the lever is correct and ready to assemble in the machine.

Gages for Canceling Segments and Cams

By Fig. 6 is shown the gage for gaging the canceling segment. This determines the proper relation to each other of the teeth, pivot, and roll. Thus when the segment is placed over the pin *F*, the second and third teeth should straddle the projection on the block *G*, and the lever *H*, which has a bearing on the roll, must have its scribed line come in exact alinement with the line on the plate.

In Fig. 7 is seen the gage that is used for the canceling shaft cam, after it has been riveted on the shaft. The shaft is placed in two bearings on the back of the machine, and the cam slid in until it touches the side of the bearing. It is then fastened there by the clamps *I I*. The periphery of the cam and its squareness to the shaft is gaged by the levers on the three different elevations of the gage. When the cam is correct, the line in the center of the lever pointers will be in alinement with the lines on the block.

Straightening and Gaging Rods

In Fig. 8 is shown a combined gage and straightener for the canceling, notched rods. The rod is shown to the right of the halftone, back of the nurled knob and also in Fig. 9.

The rod is placed across the machine so the screw, which is turned by the handle *L*, will have a bearing on it. The block that holds the screw moves back and forth,

FIG. 3. COMPTOMETER WITH CASE OFF

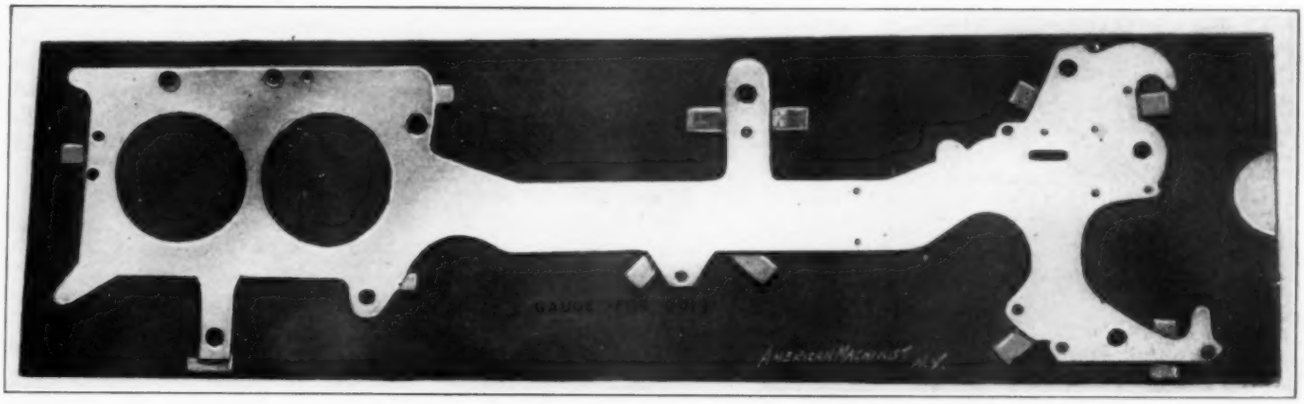


FIG. 4. FRAME SIDE AND GAGE ON WHICH IT MUST FIT AFTER REPUNCHING

across the machine, on a rod, thus the end of the screw can be made to bear on any part of the rod that is crooked and this straightened by turning the handle *L*.

The eight levers, similar to the one marked *J*, have a bearing on the flat spots on the rod and when this is straight the other end of all the levers will just touch the flat bar *K*. When the rod is being bent for straightening, the levers *J* can be moved away from it by the eccentric formed by the two rods that reach across the machines; this being turned by the nurled knob. These bars are hardened and it is very important that they should be perfectly straight.

On the end of the bar is fastened a small gear and if the teeth are in the right position, it is proved by the gage shown in Fig. 9. The rod is clamped in the first flat spot by the clamp on top of the gage and the small rod to the right that serves as a handle, is lifted up. This raises a tooth that must just fit between two teeth in the gear wheel, and proves that the gear is properly located, in relation to the flat part.

GAGING THE ACCUMULATOR

The gage shown in Fig. 10 is used for gaging the accumulator and it gages the two gears, the pawl on the under side, and one of the ten pins in the wheel; all being gaged at the same time. The accumulator consists of two gears that are about 1/16 of an inch apart, as shown in position in the gage. On the bottom of these, and consequently not shown, are

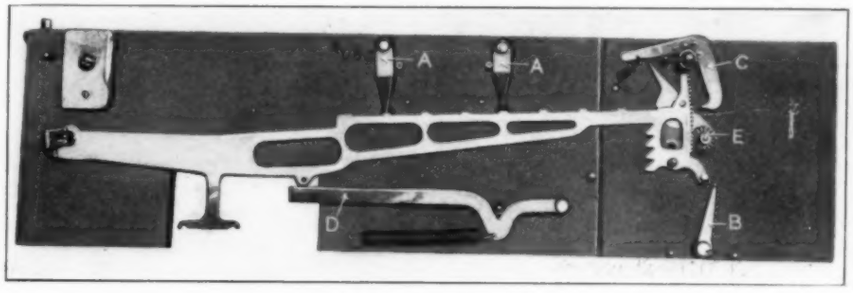


FIG. 5. GAGING SEGMENT LEVER FOR REPUNCHING, GEAR CUTTING AND PLAY

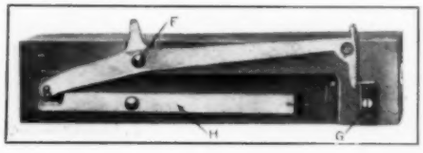


FIG. 6. GAGING TEETH, PIVOT AND ROLL ON CANCELING SEGMENT

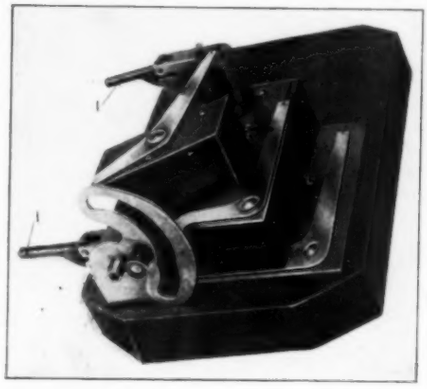


FIG. 7. GAGING PERIPHERY OF CAM AND ITS SQUARENESS TO SHAFT

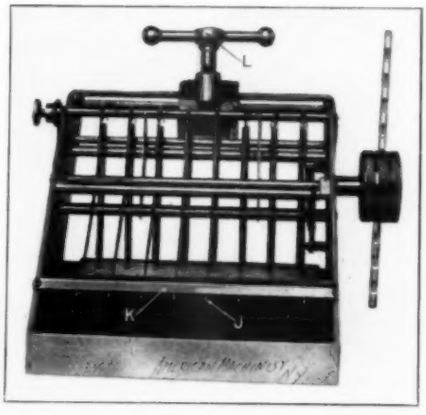


FIG. 8. GAGE FOR STRAIGHTENING THE ROD SHOWN

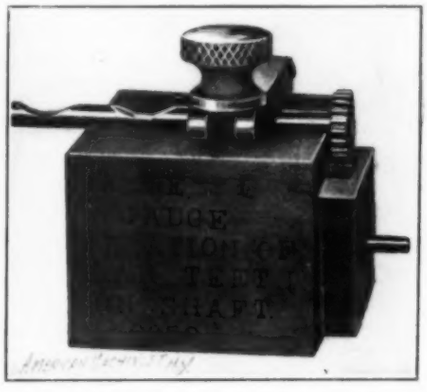


FIG. 9. LOCATING GEAR TEETH IN RELATION TO FLAT SPOT

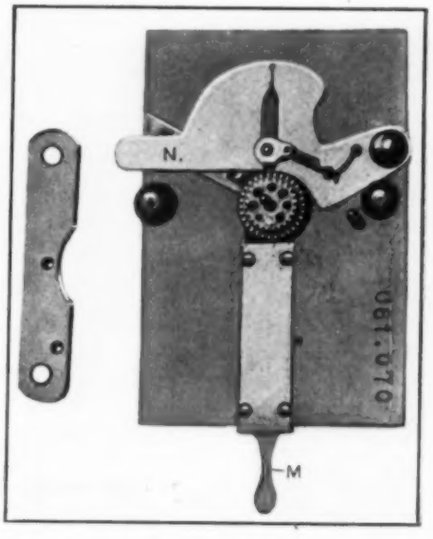


FIG. 10. GAGING TEETH ON BOTH WHEELS IN RELATION TO PAWL AND PINS ON UNDER SIDE

two plates with 10 pins between them, to correspond with the 10 numerals. On the bottom of the lower plate is located a pawl.

The accumulator is located in the gage

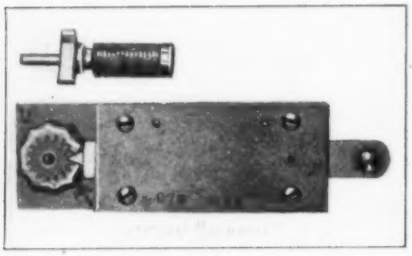


FIG. 11. GAGING TEETH OF GEAR AND RATCHET

FIG. 12. GAGING TEETH IN RELATION TO HOLES

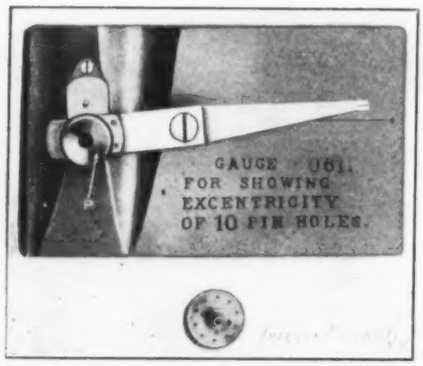


FIG. 13. GAGING ANY OF THE 10 HOLES

so the pawl and 10 pins will come in the proper position, the handle *M* is then pushed in to see if the tooth, which is located on its other end, will fit in the gear teeth of the lower wheel. After this the lever *N* is brought into position to see that its tooth fits into the teeth of the upper gear wheel. When this fits properly the pointer will swing around to the zero mark. At the left of the gage is shown a bar which must fit the two pins shown on either side of the gage and the pivot of the accumulator, to hold it in position while it is being gaged.

Testing Location of Gears and Accuracy of Drilling

The ratchet pinion shown on the gage in Fig. 11 fits over the ratchet on the bottom of the accumulator shown in the gage in Fig. 10. This ratchet fits over two pins in the gage plate that are indicated by the arrows. The sliding bar of the gage has a single tooth on its end, which must come in perfect mesh with the gear teeth when it is moved in by the handle to the left. This shows that the gear is properly located.

The gage above this is used to gage the internal teeth of the ratchet that are on the under side of the piece, as shown. When the pin enters the central hole the two projections on the gage must just fit into any two teeth of the ratchet.

In Fig. 12 is shown the style of gage the company used on all gears when milling the teeth. A certain spoke in the wheel to the right of the gage must fit between the two pins shown in the gage, and the tooth on the block *O* must just fit between

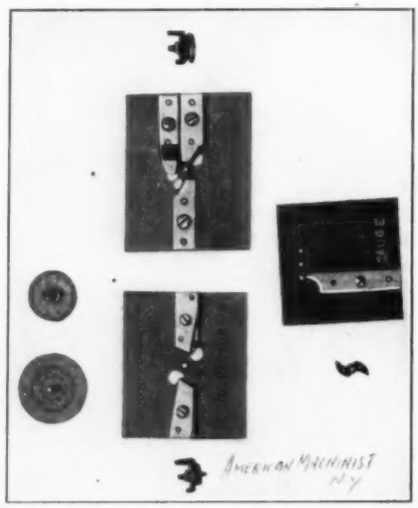


FIG. 14. GAGING SIZE AND SHAPE OF ESCAPEMENT

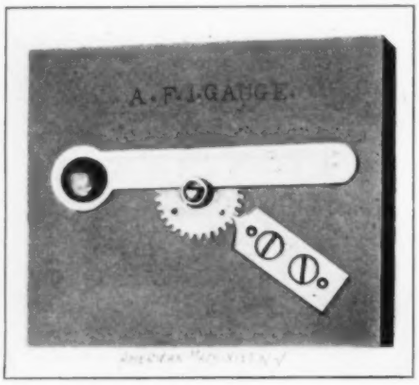


FIG. 15. GAGING FLAT SPOT

two teeth of the wheel.

The gage shown in Fig. 13 is used for gaging any of the 10 holes shown in the piece below it, and shows any defect that might occur in the drilling. The piece *P* is loose and has a pin on the bottom of it with two diameters; one of which fits in a hole in the lever, and the other in any one of the 10 holes drilled in a circle, in the piece being tested. When the piece is in the gage, and the pin in one of the holes, the center line of the pointer must line up exactly with the line scribed on the gage block.

Gages for Escapements, Canceling Gear and Subtraction Piece

The main piece of the escapement is shown at the top of Fig. 14, and after forming, this must fit the gage under it. At the bottom of the picture is shown the same piece after it has been lapped on three surfaces, or contact points, and it must then fit in the gage above it. These surfaces are lapped in a filing machine with an Arkansas stone, and must shut out light, when looking through the gage.

At the right of Fig. 14 is shown the carrying cam of the escapement. This has the central hole punched and the two small holes on each side of it drilled. These holes are gaged by slipping the piece over the three pins in the gage above it, then turning it end for end and trying

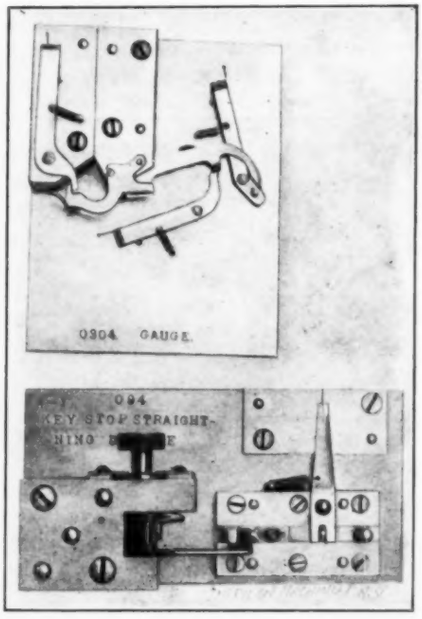


FIG. 16. GAGING SUBTRACTION PIECE

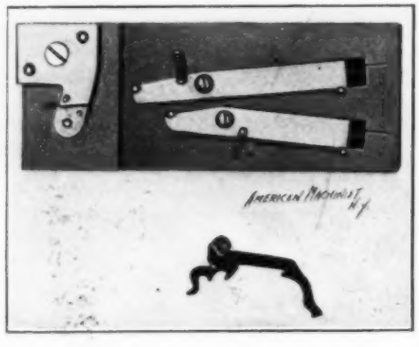


FIG. 17. GAGE FOR CARRYING HOOK

it again. If it goes on both ways it shows that the holes are perfectly in line, drilled straight, and are the correct distances apart.

At the left of Fig. 14 is shown a drill jig for drilling the 10 holes in the piece above it. This shows the method used in making jigs.

The gage shown in Fig. 15 is used for gaging the flat spot on the hub of the gear, in its relation to the teeth, its flatness, and the depth of milling. The end of the lever must come to a certain line on the plate to show that it has been flattened the proper depth, and the lever must have a bearing clear across the flat spot, when the gear fits over the tooth on the block, and the two holes over pins in the gage plate.

The subtraction piece, shown located on the upper gage in Fig. 16, is bent in a die. This piece must come from the press room exactly the right shape, and not require any bending or twisting afterward. The piece is gaged in four places at the same time and the lines in the center of the pointers must come in perfect alinement with the lines on the plate.

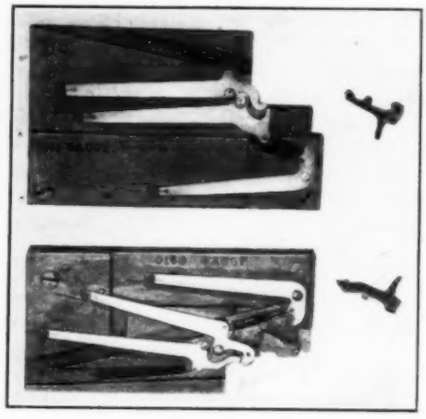


FIG. 18. GAGES FOR HOOKED AND STRAIGHT CARRYING DETENTS

The lower gage in Fig. 16 is used for straightening the key stop and the pointer coming to its line indicated when the piece has been properly pressed to shape. The carrying hook is shown at the bottom of Fig. 17, and it is gaged in two places by the gage shown above it.

Carrying Detent Gages

The straight and hooked carrying detents are shown to the right of Fig. 18 and their respective gages to the left. These pieces are gaged in three places by the levers shown, the pointers of which must come to their proper lines on the plate. These carrying detents are made right- and left-hand, and consequently two other gages, the opposite hand to those shown, are used.

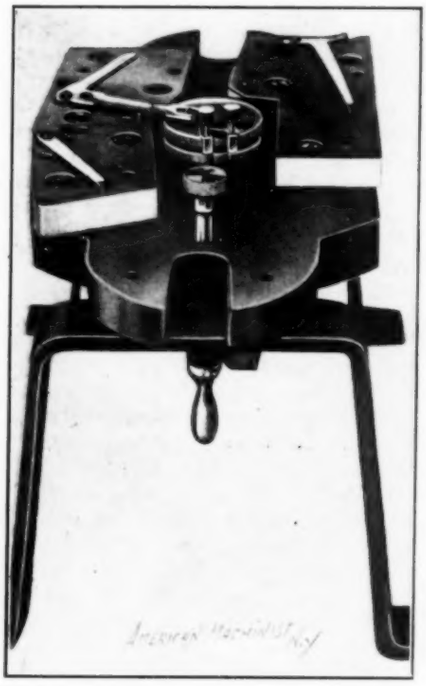


FIG. 19. ANOTHER GAGE FOR THE CARRYING DETENTS

Another gage was made for the inspection department, as shown in Fig. 19, so all the carrying detents could be gaged on it; that is, the right- and left-hand of both the straight and hooked pieces. This gage has a number of levers with indicator points, all of which are multiples of 8 to 1, except one, and that is 16 to 1. This gage tells when the proper curve has been given the ears of the detents by the press die and when the point that hooks over the escapement are correct. It also acts as a check on the gages shown in Fig. 18.

When the opposite hand of a piece is being tested the pin with the nurled knob on the top of the plate is pulled out, the handle under the plate is reversed to the opposite end, and the pin put in a hole at that end. Only the levers which gage one piece are shown, as the others cannot be located on the plate at the same time. This is a very complicated gage, and took $450 worth of a toolmaker's time in making it.

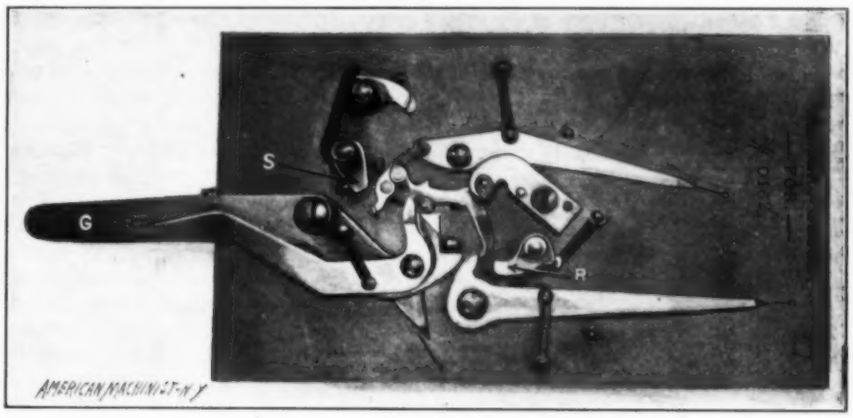


FIG. 20. GAGING MAIN PIECE OF CARRYING BELL CRANK

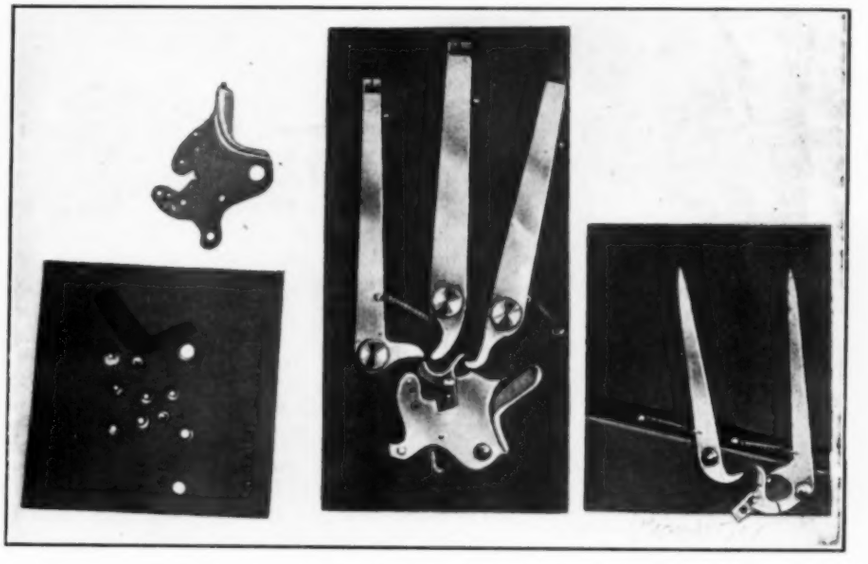


FIG. 21. GAGES FOR FRONT INTERSECTION AND PAWL

Bell Crank and Front Intersection Gages

The gage that is used for the main piece of the carrying bell crank is shown in Fig. 20. When the piece is in position, and the long lever *G* is pressed to the left as far as it will go, all of the three pointers must be exactly on their lines. The levers *R* and *S* are made to swing under the piece and just touch without raising it, while the side of the chamfer must touch in passing without undue pressure. This

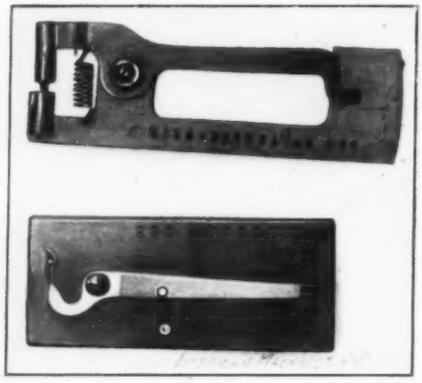


FIG. 22. GAGING PAWL

FIG. 23. GAGES FOR PIECE SHOWN

makes six points that are gaged on the one piece and each one must be absolutely correct.

The front intersecting piece and its pawl are gaged on the two gages shown in Fig. 21. The front intersecting piece is shown in the upper left-hand corner, as it comes from the press room, with all of the holes repunched. All of the eight holes must then be so accurate that the piece can easily be pressed down over the pins, in the gage to the left of the halftone, and each hole be a tight fit without any of them being sheared by the sharp edges of the square-topped pins.

The pawl is gaged in two places, on the gage to the left, after they have been milled. The two pieces are then put together, and three places are gaged with the gage in the center. The line in the center of each pointer must come exactly to the corresponding line on the plate before the piece is passed.

The gage in Fig. 22 gages the length of the pawl after the end has been milled, and the upper gage is to show that the counterbore has been given the proper depth.

The four gages shown in Fig. 23 are used to gage the piece shown in the center. The one in the lower left-hand corner is to show that it has been milled to proper form, the one in the upper left-hand corner is to gage the depth of the counterbore, and the one in the upper right-hand corner is to gage the length. The master gage, shown in the lower right-hand corner, is used for trying out the other gages, and also for testing the angle of the milled end of the piece.

These gages show the accuracy which must be used in making the comptometer as well as the precision and skill which must be used in punching out the different parts, and milling, drilling or otherwise machining them. This accuracy is due to the fact that the machine must be so built that it will not make any mistake, and so it will not be possible to make any no matter how quickly the keys may be pressed.

Errors in Scales

By G. G. Gload

Unfortunately, I am a toolmaker, also the owner of a 6-inch flexible rule, in fact, two of them, same make, same length, etc.; this is not all the tools which I own, however, as I have a pair of 3-inch dividers also.

I have been the owner of these rules for several years, having worn out two or three previous to these and thinking it a good plan to have two, so as to be able to locate at least one when wanted, I made the double purchase.

Having settled down in a new position where the flexible rules are called upon for an unusual amount of service, either one or the other is pretty busy most of the time as are also the dividers, I having a great deal of spacing to do.

The other day I set the dividers to a certain size on one of the rules, as I had done perhaps hundreds of times. Wishing to be very exact I verified my setting and found the dividers were not as expected. I changed the setting and having everything in order started to lay out a die. When about finished spacing off the holes, I once more verified the dividers and found they were again not quite as expected, as my spacing had finally grown to about 0.015 inch over size. I said the usual number of unkind words and in about the manner a man would be expected to say them under the circumstances, then I proceeded to investigate.

In setting the dividers to any given size, it was almost impossible to find another space on the rule of the same size.

Evidently the maker had gotten a sufficient number of graduations in each inch and seemed satisfied with his job. There were 32 in each and every inch on one side, and the other had 64 without a miss, nevertheless, rule No. 1 was laid aside in disgrace.

Rule No. 2, being a twin brother to the other, proved as unreliable as the first. This also was laid aside in disgrace. I then applied the test to a new 9-inch heavy rule, and found the spacing to be correct in every particular.

Now why did it take several years to find this out? The answer may be that the present work is more exacting than that of previous years but this is far from correct, as these scales have seen several States and have done service in a variety of work.

It may be because one is liable to take things for granted and consider everything correct which bears a certain maker's name, or it may be that there are some things which we would think are correct enough anyway, and we never think of testing them, or, possibly it takes a *toolmaker* several years to discover an error. At any rate, while there was no stamping or marking on the rules to destroy their accuracy, the error was there and it took several years to find it out, but why did it take so long?

It is stated in a French contemporary that the best soldering medium for aluminum is an alloy of that metal and tin. The proportions vary according to the extent to which the soldered articles are intended to be worked; 45 parts of tin and 15 of aluminum forming a good solder for such as are to be shaped afterward. A harder solder, but less easily applied with the soldering iron, is prepared by melting 4½ parts of red copper, to which are then added 3½ parts of zinc and 4½ of tin, the heating being continued until a homogeneous alloy is obtained. In *The Metal Industry* it is stated that the surface of all aluminum is covered with a thin, invisible coating of aluminum oxide, and that this coating forms instantly after the surface is cleaned; it is very refractory, and is soluble only in hydrofluoric acid. It is necessary, therefore, to remove this coating of oxide simultaneously with the soldering operation, and this is best accomplished mechanically by abrading the surface with a steel or brass scratch brush while the solder on the surface is still molten.

U. S. Navy Specifications for Tool Steel

The Chemical Composition and Physical Characteristics Adopted by the Navy for Purchase of Tool Steel, Especially High Speed Steel

BY HENRY WILLIAMS*

It is a noteworthy fact that many large corporations have adopted the method of purchasing on specifications the supplies and materials required for their work, awarding contracts only after competitive bidding among firms supplying such articles. This method results in reducing the cost and places purchases on a proper basis both as regards the buyers and the sellers. In spite of statements that responsible firms will name the same price whether subjected to competition or not, it has occurred repeatedly that materially lower prices have been quoted on articles under competitive purchase than were paid on the same articles previously purchased without competition.

The chief objection to the method is the difficulty encountered in framing specifications which will permit competitive bidding on equal basis and which also will insure the receipt of articles adaptable to the purposes intended. Specifications to be effective must not be drawn so stringently as to require characteristics which would add to the cost without increasing the practical value of the material as regards its designed use; neither should they be so loosely drawn as to invite bids on materials of lower grade than actually desired or contemplated.

Departments of the Government are required by law to purchase supplies after competition and the benefits of this system have been apparent for a long time. Among the various branches of the Government the Navy Department is, undoubtedly, the largest purchaser of materials, which range from a completed battleship, at a total contract price of over $4,000,000, to small quantities of supplies, for use in maintaining ships in commission, or for navy-yard work.

In purchasing a battleship, elaborate specifications, comprising 500 or more pages of printed matter, and a number of so-called "contract plans" are used. For the purchase of ordinary supplies, specifications, not so elaborate are used, each covering a particular class of material. The list of specifications for materials used by the Navy Department is by no means complete and it is being added to continually and new specifications are being prepared to fill deficiencies.

Objections to Specifications on Tool Steel

Up to a comparatively recent date tool steel, especially high-speed tool steel, was regarded as not susceptible to such description by specifications as to permit competition and insure the delivery of satisfactory material.

The method by which the naval authorities met the situation and the procedure which led finally to the present method of purchase of high-speed tool steel under specifications mentioning chemical composition and physical characteristics, should be of interest, especially as, so far as the writer has been able to ascertain, no other large user of tool steel purchases it under specifications.

As long as there were no specifications to cover it, the purchase of tool steel for naval use presented many embarrassing features; each case required special arrangements and it was considered necessary in each purchase to mention one or more particular proprietary brands as being the only ones that would meet the requirements of the work for which it was intended. This resulted either in eliminating competition or in inviting competition among grades of steel having no just basis for comparison.

In order that consideration might be given to all brands of tool steel in the market, and to select the ones best suited, elaborate tests were conducted from time to time to determine which of the brands of tool steel were most suitable to the special requirements of the navy.

These tests developed usually the fact that all of the several brands of high-grade tool steel tested were of approximately equal quality and that any one of them would give in use generally satisfactory results.

Treatment of Tool Steel

Many of the navy yard officials, however, held the opinion that it was desirable to use exclusively tool steel of one brand on account of the difficulty, otherwise, encountered in obtaining proper heat treatment of tools. It was realized that tool dressers became familiar with steel of a particular composition or brand and were skilled in its treatment.

It was also realized that other brands of tool steel introduced might receive on first working the treatment recommended by their manufacturers, but, when redressing was required after having been in the yard, the chance was remote of the tool being treated according to any special method. As a result these tools failed to give satisfaction and were condemned.

Tools made from steel with which the tool dressers were familiar were treated according to the proper method for them and so navy-yard authorities became more convinced of the necessity of securing, whenever purchased, the particular brand of tool steel in question.

Protests of Steelmakers

It did not follow that the different navy yards and stations decided upon the same brand of steel as being best suited to their needs, and it occurred frequently that requisitions from different yards specified different brands of tool steel for the same work.

While the method of purchasing which permitted them to obtain whatever brand of tool steel that each believed to be the only one which would meet their requirements, was satisfactory to the yards, it had several unfortunate defects; the principal one of which was that certain firms, whose product was not approved, protested vigorously against being excluded from a share of the business.

These protests of the firms shut out were entirely reasonable because, as was before stated, under the requirements of law, materials for the naval service must be purchased in the open market, after advertisement and due competition. When certain specified brands of material are required, it is necessary for the official responsible for its use to certify that this particular brand and *no other* will meet the requirements of the service for which it is intended.

Difficulties Encountered with Comparative Tests

In view of the above considerations, the responsible officials of the Navy Department decided that competition should be introduced into the purchase of tool steel.

As a first step in this direction it was ordered, where a particular brand was specified in the requisition, that bids would be considered for other brands that could be shown to have proved satisfactory, in naval or commercial use, for the purpose intended.

In order that consideration might be given to such bids it was decided that all bidders should be required to submit samples at the time of bidding, the award of contract to be based on the results of tests of these samples, the lowest bidder whose samples were found to be satisfactory to be awarded the contract. The successful bidder was required to submit with each delivery a statement from the manufacturers of the steel, certifying it to be of

*Naval constructor, United States Navy Yard, at Washington, D. C., and members of board of four naval officers that drew up the specifications.

the grade and quality of the sample submitted with the bid.

This method of purchase presented several difficulties. It was found that bidders questioned the results of the competitive tests of samples submitted, stating that the samples had not in certain cases been subjected to proper treatment.

Comparative Tests and Their Cost

They demanded the right to have their representatives treat their samples, although it was pointed out that the intention was to conduct the tests of the samples under the conditions that would obtain in the use of the tool steel, and that were the contract awarded on the basis of tests made by the steel company's experts, it could not be expected that similar results would be obtained by the navy-yard tool dressers.

Another objection to the system of purhasing tool steel by comparative tests was that, through purchase of tool steel for stock in this way, the different brands in stock became mixed, and when tools were being made up it was difficult to determine the proper treatment to be given to obtain the best results as recommended by the manufacturer. When the tools were made up, used and returned for redressing, it was practically impossible to determine the brands of the steel, or the best method of treatment.

In addition to these objections, there was the further very serious one of cost and time consumed in conducting the comparative tests of samples. On one schedule, containing over 700 items of tool steel, there were submitted by bidders several hundred samples to be tested before the contract could be awarded. This schedule included a great variety of sizes, shapes, grades and brands, and covered supplies for the five principal East coast navy yards.

Necessity of Specifications

As a result of the accumulation of experience in purchasing tool steel it was decided finally that it was absolutely essential to place the purchase of tool steel for all navy yards on a specification basis, in order to insure that all the competitive bidding would be on material of the required quality, and thereby diminish the varieties of grades, shapes and sizes of tool steel used.

To accomplish this result the Secretary of the Navy ordered, to consider this matter, a board of four naval officers representing the several technical bureaus of the Navy Department.

The Board, as a preliminary step, with a view to determining the practice in manufacturing establishments, addressed letters to various shipyards and large concerns which used tool steel under conditions similar to those obtaining in the naval establishments, requesting that such information as they were willing to furnish, be given relative to the method adopted by them in purchasing tool steel; if such purchases were made after competition or whether approved proprietary brands were purchased, and, if so, upon what considerations was based the decision as to which brands should be purchased.

Letter to Steel Makers

Letters were also addressed to tool-steel makers as follows:

"The Navy Department having appointed a Board to consider the general question of tool steel for use of the naval service, with especial reference to determining: 1st. Quality desired, and the necessary chemical composition to obtain this quality. 2d. The shapes desired. 3d. The sizes desired. In order to enable the Board to base its recommendations on conditions as actually existing in the trade, it would be pleased to receive from you any suggestions you may desire to make, relative to the above points, and any other points which you may consider pertinent. In this connection it is to be noted that the laws governing purchase of materials for the navy require that such purchases should be made, wherever practicable, after competition, and that the contract should be awarded, in each case, to the lowest responsible bidder offering material which will, in the opinion of the responsible officials, meet the requirements for the purpose for which intended. The Board requests that any suggestions which you may make be based on the above conditions which are matters of law and beyond the control of the Navy Department."

Competitive Tests in General Use

Letters were addressed to the commandants at each of the navy yards requesting that statements be submitted by the heads of the yard departments relative to tool steel for their uses, with especial reference to the sizes and shapes necessary and the proprietary brands which had been utilized and found to be satisfactory, and the necessity for utilizing any particular proprietary brand.

Prompt replies were received and the information was conclusive as showing the general practice of industrial establishments in selecting tool steel, the views of tool-steel makers as to the feasibility of purchasing tool steel under specifications, and the views of navy-yard officials as to the desirability of continuing the use of the particular brands of steel to which they were accustomed.

It was ascertained that the practice of those shipyards and industrial concerns to which the Board had addressed letters, was to select steel for their uses by testing different brands presented from time to time, and making purchases of those found to meet the requirements best.

The following extract from the letter received from one of the largest shipbuilding concerns, indicates the general practice in this matter:

"We require tool steel for a great variety of purposes and simply purchase proprietary brands that have shown from our past experience to be the most suitable for the particular kind of work in question. We always stand ready to put any new steel that comes along in direct competition on the same kind of work with our other steels in use and if any marked superiority is shown we make further tests of the steel in actual service."

Steel Makers Say Chemical Specifications Are Impractical

The navy-yard authorities were generally unanimous in their desire to continue using the particular brands of tool steel to which they had become accustomed and had found best for their work, although there were some officers who were convinced as to the desirability of purchasing tool steel under specifications.

The tool-steel makers addressed, though expressing willingness to do all in their power to aid the Board in its work, were unable to offer any suggestions of value and were generally agreed in stating a chemical specification for tool steel to be impracticable. The following extract from the letter of one of the largest makers indicates the consensus of their opinion:

"In the first place, tool steel is the most difficult of all grades which the steel manufacturer is called upon to supply and probably requires more and longer experience to successfully make than any other class of steel. . . . . Now it would seem to be a hopeless task to try to embody these years of experience in a few requirements and to expect that such a specification would secure for the Government good steel. I believe that the best method to be pursued in buying tool steel, either by a commercial concern or by the Government, is to use the tool steel from which they get the best results in actual experience. I believe this is the best way, because there are too many important elements that enter into the manufacture of tool steel to be covered by any reasonable specifications."

Desirability of Specifications

As a result of its preliminary investigations, the Board was convinced, in spite of the almost overwhelming consensus of opinion to the contrary, of the desirability of formulating specifications, sufficiently exact to permit of the purchase of tool steel after competition, and to insure the receipt of tool steel that would respond to uniform methods of treatment to be specified in each case.

This feature was regarded by the Board as most important, as diversity of methods of treatment was the ground upon which most of the yards justly based their

objections to using promiscuously the various brands of tool steel.

It developed that not only was a chemical specification necessary, but that also definite physical properties should be required in order to insure the delivery of tool steel not spoiled in the making. The Board, having reached this conclusion, was confronted with the difficult problem of determining formulas and methods of treatment for each of the grades of tool steel which it decided were necessary for navy-yard work.

High-speed Steel

Attention was devoted first to high-speed tool steel as being the most important, not only as regarded its price, quantity purchased, and character of work per formed by it, but also as being the grade of steel the purchase of which had presented in the past the most difficulties.

A chemical formula representing high-speed tool steel that had given excellent results under exhaustive tests, was adopted by the Board and the following specifications were drafted covering this composition and physical characteristics corresponding:

1. The steel shall be made by the crucible process, and shall be of uniform quality throughout, and shall be delivered in bars of commercial length, no short bars to be received, and shall be delivered annealed unless otherwise specified. The bars shall be free from all seams, cracks, and other mechanical defects.

2. The steel shall be delivered and inspected in lots of not more than 5000 pounds, unless otherwise specified, each lot containing its proper proportion of the sizes called for on the requisition.

3. The inspection shall be made at the Navy Yard, League island, Penn., and shall be under the direction of an officer detailed for that duty by the Commandant of the yard.

4. Each bar, up to and including a sectional area of 2¼ square inches, shall be delivered with a test piece on one end about one and one-half times the larger dimension of the bar in length, nicked one-quarter through from each side while bar was hot, so that the test piece may be easily broken off. Larger bars to have coupon test piece forged on one end and nicked as stated above. The test piece must be stamped to match the number of the bar, and when forged down as a coupon must be about 1x1½ inches and about 3 inches long.

High-heat Test

5. The test piece from each bar will be broken off and subjected to a higher heat test in an approved furnace, kept at a definite uniform temperature, which shall be as high as practicable. The test piece, when broken off the end of the bar, should show the fine grain which is characteristic of this class of high-speed tool steel when properly made.

6. The test piece shall be preheated slowly and thoroughly in a preheating furnace kept at a uniform temperature of about 1550 degrees Fahrenheit. When thoroughly heated the test piece shall be quickly transferred to the high-heat furnace and rapidly heated to just below the melting point, then promptly removed from the furnace and blown cold in a heavy blast of air.

7. Each test piece shall then have ground off one end by wet emery grinder an amount at least equal to one-half the thickness of the test piece, leaving the end after grinding a V-shape. This V-end shall then test "file hard." Each bar failing in this test shall be rejected and another bar furnished in its stead by the contractors, and failure of 10 per cent. of the bars in any lot to meet this test shall reject that lot.

Chemical Analysis

8. Chemical analysis shall be taken and the steel of each lot shall show the following maximum and minimum limits for the elements named:

	Not Less Than—	Not More Than—
	Per Cent.	Per Cent.
Tungsten	18.50	19.50
Chromium	5.25	6.00
Vanadium	.10	.35
Carbon	0.55	0.75
Manganese	.....	0.15
Silicon	.....	0.110
Phosphorus	.....	0.020
Sulphur	.....	0.020

There shall be no other impurities or ingredients, except iron, particularly no molybdenum.

Physical Characteristics

9. From each lot of tool steel one or more tools shall be forged and treated with the standard high-heat treatment and ground to a uniform standard shape of cutting edge for lathe tools; these tools shall be given a standard 20-minute test on a steel forging of the following chemical and physical characteristics, viz, to be open-hearth, either nickel or carbon steel, annealed:

Minimum tensile strength, 80,000 pounds.

Minimum elastic limit, 50,000 pounds.

Minimum elongation in 2 inches (cold bend about an inner diameter of 1 inch through 180 degrees), 25 per cent.

Maximum phosphorus, 0.06 per cent.

Maximum sulphur, 0.04 per cent.

The lathe tool, known as the standard ⅞-inch tool, shall be able to take a cut of 3/16 inch depth, with 1/16 inch feed, at surface speed of 60 feet per minute.

Central Tool-grinding and Dressing Plant

The Board coupled with its report on specifications for high-speed steel, a recommendation relative to the establishment of a central tool-grinding and tool-dressing plant not only for the manufacture of tools but for making the tests required by the specifications.

It was anticipated that high-speed tool steel in accordance with the specifications probably would be more expensive than the kinds previously purchased. This expected increase in price was to be offset by the greater efficiency of the tool steel and the more satisfactory conditions that would result from having a definite heat treatment. It was realized, further, that the question of net saving from the use of better quality tool steel would depend largely upon whether the shop system and management were adapted to taking full advantage of the better and more uniform tool steel used.

Prices Obtained

Contrary to expectations, however, it was found that manufacturers bid extremely low prices on the high-speed tool steel purchased under the specifications, several large contracts having been let at a price of 34 cents a pound and less, as against prices previously paid varying from 40 to 60 cents.

The results obtained in this way from the purchase of high-speed tool steel under specifications surpassed the most sanguine hopes of those interested in their success, and the Navy thus has been the pioneer in purchasing under specifications an article that was believed not to be susceptible of purchase in that manner.

Carbon Steel

Further work of the Tool Steel Board consisted in endeavoring to formulate also specifications for the various grades of carbon tool steel necessary for navy-yard work. There was not sufficient information available to permit of conclusive action, for the reason that the number of grades used for the different work was very great, and it did not appear desirable as yet to fix in detail the characteristics of the grades used. It was decided, however, that three grades of carbon steel should meet all reasonable requirements for navy-yard work, and the approximate characteristics of these were fixed by the Board and the grades designated as A, B and C. Tool steel will be purchased in accordance with the characteristics specified by the Board for each, and if after experience it is found to meet satisfactorily the requirements in service, further detailed specifications covering each grade of carbon tool steel will be adopted. Experiments are being conducted to determine accurate method of treating each grade in order to give the best and most uniform results.

In the imports of Chile for 1908, machinery and fuel were the only items of importance that showed an increase. Machinery showed an increase of $1,965,871, and fuel and industrial oils $1,916,579, while the total imparts showed a loss of $9,990,787.

Piece Work—Noisy Gears and the Question of Experience

By John R. Godfrey

I have run up against several interesting samples of piece-work and its applications lately, that emphasize some of the difficulties on both sides of the fence, even where both sides would like to play fair, which doesn't always seem to be the case.

Jack Summers was foreman of a screw-machine job which was too small for the rest of the shop so that he was always at least one lap behind and hustling as only a constant nagging for rush work will make any man. One of his men quit and a fellow from the next town drifted in after the job.

'Twas a cheap job so that by everlasting hustling the men had been making 20 cents an hour on the work, and the new chap wasn't overjoyed at the prospect, but he needed the money and started in.

He was a hustler from Hustlerville, and before the day was over he'd got onto the curves of the machine and the work and ended the day with 24 cents an hour to his credit, more than anyone had ever made. Next day he went to Summers and said, "How much do I dare make in this shop?"

Now Jack was looking for production—he wanted to be able to tell the rest of the shop to go to ——, when the stock clerk came to count up the screw-machine job and he was ready to risk a good deal to help along the good work.

"Well, I'm not quite the whole shooting match here and I can't give any iron-clad guarantee, but so far as I'm able," and the fellow saw he looked him square in the eye and meant it, "I'll prevent any cut in the rate no matter what you make."

Then the screw-machine man started in, and the way the chips flew was an eye opener to even Jack Summers. Says he never saw a man work so fast or make so few false movements in all his experience. And his earnings climbed up to as high as 40 and 42 cents an hour.

Of course, the office kicked; no man had any right to earn anywhere near $4 a day on a screw machine, and Jack had his hands full to keep his word. If he hadn't been able to show them that he was keeping the production of his department up to the rest, there would have been an earthquake right on the spot.

Then, too, the manager swore the rest of the men were loafing, not realizing that there is a tremendous difference in men. Once in awhile there is a man who can double the average output and this was a case of that kind. Cutting the rate meant starving the other men, and even the manager could see that it wouldn't be quite a square deal to cut the rate on the "phenom" and not the others, so it stood.

Fortunately for the peace of mind of the manager, the star performer left to go back to his old job and things jogged along in the same old way, except for a general improvement in the output due to the rest of the men catching onto a few of the little kinks that enabled the expert to turn out so much work.

But the manager was happy, regardless of the fact that the output from one machine had been cut nearly in two; he was one of the kind who couldn't see anything but the pay-roll. Nevertheless the coming and going of the expert had a good effect, as the general tone of the shop is much better than before and more work is being produced.

Quiet Running Gears

I'm beginning to believe that there's a whole lot about gears that we haven't learned even yet. The main object in most cases is to get a quiet running gear, after of course, providing for strength enough to resist breaking strains. So I find one man making his printing press driving gear, very similar to what we call a bull gear on a planer, with only a 4-degree pressure angle, which means a practically straight tooth. Says it's the only gear tooth he can get that drives steadily and quietly for printing-press work.

Then I find some of my automobile friends using the standard 14½-degree, long involute tooth as the only quiet gear for automobile transmissions. Others, building an equally good car, use a 20-degree stub tooth of the Fellows persuasion, while a case recently came to my ears of still another man who claimed that the only quiet gears he could get had a 45-degree pressure angle. Now it's a long jump from 4 to 45 degrees, one with almost no crowding or thrust and the other with hardly anything else, yet both giving satisfactory results in their place.

My acquaintances among the automobile testers, tell me that nearly all their troubles come from the gears. The motors are nearly all right in every case, but the gears, both in the transmission case, and in the driving box at the back, especially the latter, give them all kinds of trouble, before they get them to run quietly. Probably it is the mounting as much as anything, a slight variation making considerable difference so far as noise is concerned.

My friend Burgess believes that the spiral or helical tooth will go a long way toward securing quiet gears, but it only helps out the spur-gear question as yet. He seems to make good on his proposition too, by making gears with helical teeth that run from 2000 to 4000 turns a minute and still are not declared a public nuisance, in fact run more quietly than most of us ever heard gears run at anywhere near these speeds.

But, taken altogether, it seems to show that there is a lot yet to learn about gears, even among those who use them in large quantities and are interested in knowing what is what in gearing.

What is Experience?

Perhaps it would be better to ask how experience is to be gained; although it is the common notion that the man who has knocked around in all kinds of shops is the star performer when it comes to being a machinist.

But we often find a young man who has never worked in any other shop, cutting circles around the "experienced" man both as to quantity and quality of work. True he is what we call a specialist or an operator and he might be stumped at some of the repair jobs the other man has been up against, but the chances are he can take hold of any other machine tool in the shop and soon become expert on that also.

One of the brightest shop superintendents I know, and he is a practical man with a big P, contends that real experience depends on the man's mind and not where he keeps his body. He may work in forty different shops and if his mind is not active, he is not gaining real experience, while the man who reads good mechanical papers, whether he travels or not, is getting more real experience than the other man.

He cites as examples some of our articles on lathe and boring-mill work, claiming that these give a man the methods followed by so many more shops and cover so many more tools than one man could possibly work in or on, that the reader has much the best chance of the two, aside from the lower cost and the fact that you need not break all social ties while you are doing it.

This does not mean that anyone can become skilled at any particular operation by reading or studying how it is done, but there is after all, an underlying principle for all metal-cutting operations and the different tools are simply varying applications of the same thing. So that the real difference is in knowing how to handle the machines, how to hold the work and the various kinks, about which much can be learned from a good illustrated article written by a practical man.

In this way you can get in touch with the best methods of the various shops in the different parts of the country and often know more of the details than you would from a visit to the shop itself; and it must be clear that no man could learn all this by actually working on them in all the shops because life is too short.

The world's gold production, according to the "Statistical Abstract of the United States," to be issued by the Department of Commerce and Labor, aggregates, from the discovery of America to the present time, thirteen billion dollars. The amount of this gold now in existence is estimated at eleven billion dollars, of which seven billions are in the form of gold coin, three billions being in circulation, and the remaining four billions in banks and public treasuries.

The Making of Automobile Tires

A Live Industry in Which Modern Invention Is Supplanting Antiquated and Uncertain Hand Methods by the Uniformity of Special Machinery

BY SNOWDEN B. REDFIELD

For many years the "rubber man" has been considered very close as regards information about the making of his various products.

A more or less ragged story bearing on this subject has it that one rubber manufacturer desiring to discover some of the secrets of one of his competitors disguised himself as a minister and applying at the office of the rival rubber works he stated that he was looking for some general information in regard to manufacturing which would help him in a certain sermon which he was endeavoring to prepare. After a critical examination of his face and his costume he was very politely shown through the mill.

At one point the minister asked if he might take home with him a small sample of the rubber and upon having received permission, he took out his penknife to cut a small piece from one of the piles near by. Before making a cut, however, he passed his knife blade between his lips, and as a rubber man knows that a wet knife will cut rubber where a dry one will not and very few other people know this fact, it took but an instant to seize upon the bogus minister and cast him out the back door.

Pursuant of this policy, it is not strange that there are many old-fashioned ways of making rubber goods, largely employing hand labor, still in existence. The accompanying photographs, however, taken in the plant of the Goodyear Tire and Rubber Company, at Akron, O., are illustrative of an uptodate policy involving the use of modern machinery to do the work which is still very largely done by hand in many places.

The machine, which is of particular interest as a direct replacer of uncertain hand methods of making automobile tires, substituting therefor exact machine methods, is illustrated in Fig. 1 and also in Fig. 5, while Fig. 4 illustrates the manual method still very largely in use. As very little is known to the general public in regard to the manipulation of rubber and as automobile tires are a product which is of very real interest at the present time, a description of the process of manufacture will not be out of place.

Mechanical Mastication

The rubber gum in the crude state comes from the South American rubber plantations in irregular lumps, its general appearance and the size of the lumps depending upon the kind of gum. In Fig. 2 the steel tank, as will be seen, contains these irregular lumps of crude gum, which are soaking in hot water, the purpose of this being to soften and clean the lumps of gum. After this soaking for a considerable length of time, these lumps are passed through the grinding or masticating machines which are seen in the background of Fig. 2.

These machines consist essentially of a pair of toothed rolls of very heavy construction and requiring considerable power to do their work. One of the rolls travels about three times as fast as its

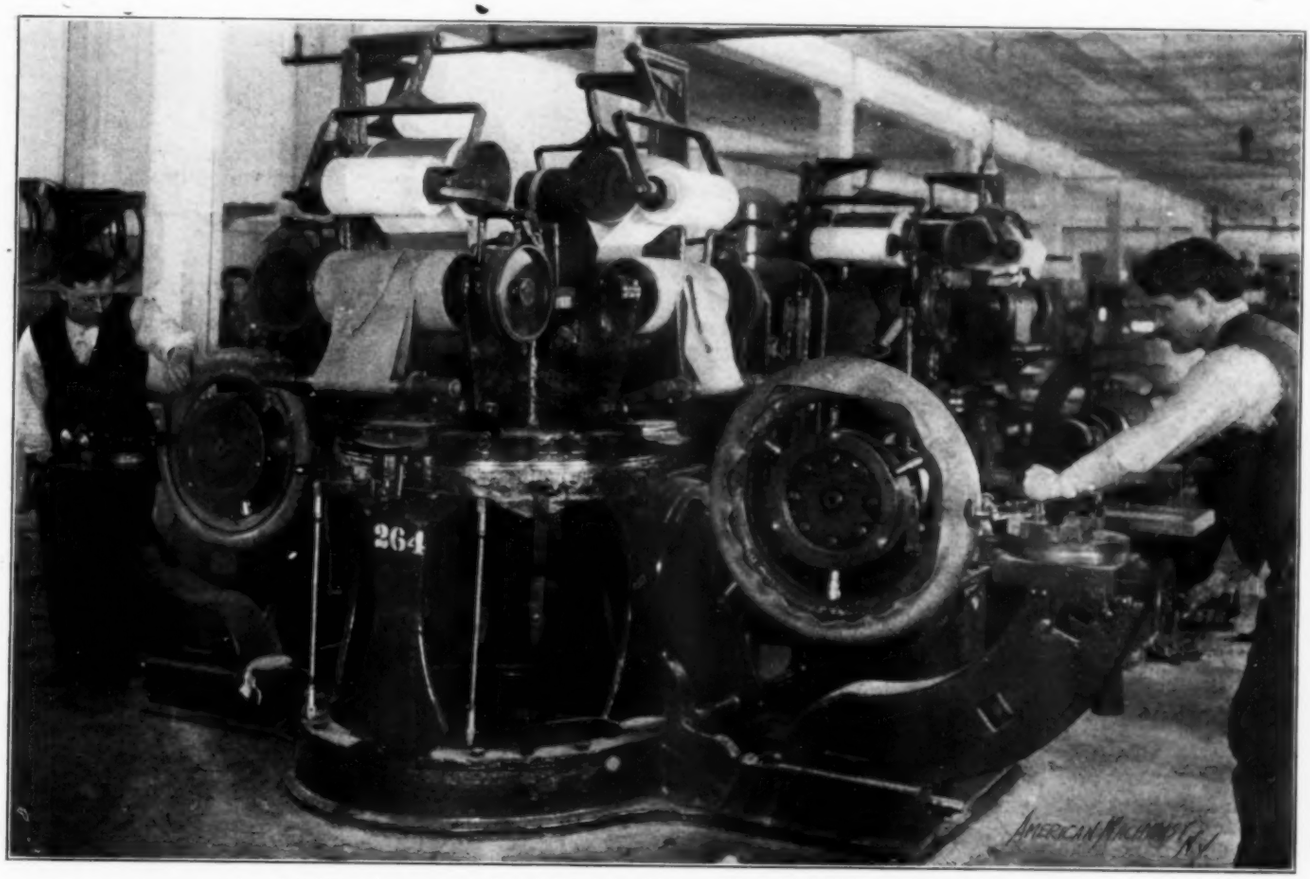


FIG. 1. A MACHINE MADE AUTOMOBILE TIRE. ROLLING THE LAYERS INTO PLACE. GOODYEAR TIRE AND RUBBER COMPANY, AKRON, O.

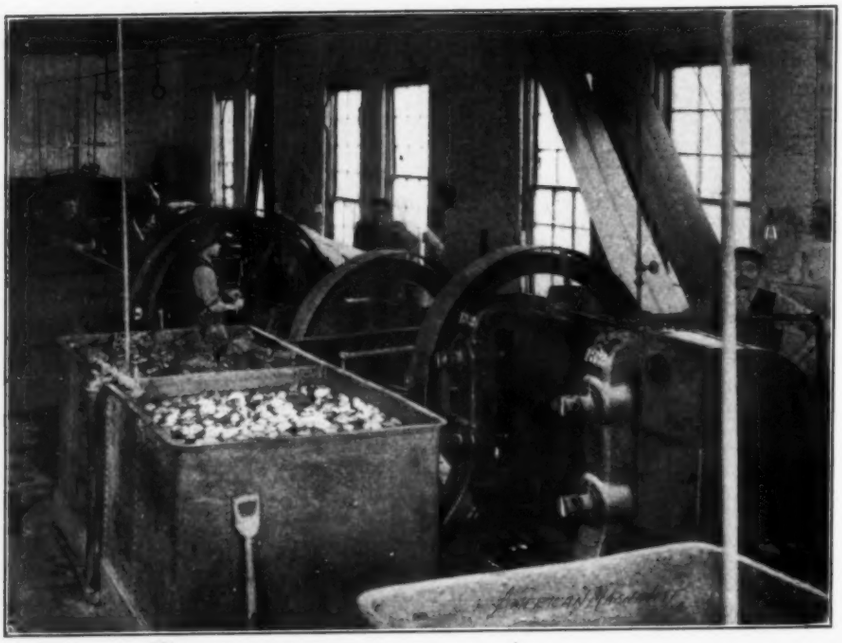


FIG. 2. GRINDING OR MASTICATING ROLLS

neighbor and, as intimated, both rolls are provided on their surfaces with heavy pyramidal projections, or teeth. The projections are in parallel rings around the rolls and those on one row coincide with the grooves on the other roll so that the two rolls, although each are provided with projections, and as said, one traveling three times as fast as the other, are made to travel quite close together.

The surfaces of the rolls are flooded with cold water and the irregular lumps of gum which have come from the softening tank are thrown in between these rough rollers, which it should be said, are, of course, both revolving inward tending to draw the gum down in between them. The gum is very stiff, but the projections on the rolls draw it down between them, crowding the lumps into the very small space between the projections, and the different speeds of the two rolls cause the gum to be thoroughly crushed and torn apart; in fact the word "mastication," or chewing, describes this action best. It is in reality a very powerful tearing asunder of the fibers of the gum which is passed round and round through the rolls a great number of times until thoroughly masticated.

Sheeting and Drying

After this thorough chewing the material is passed through other sets of rolls differing from the first set only in the fact that they are provided with shallow corrugations along their surfaces instead of projections, and by passing the now mastigated gum between this second set of rolls the material is formed into strips or sheets and the process is termed sheeting. These rolls also revolve at different speeds. As the material passes down between the corrugated rolls it comes out in a band underneath. The operator catches the loose end and feeds it again into the top of the machine, which produces an endless band of the gum, which is full of pits and indentations resembling very closely a rubber sponge or a sheet of rubber sponge material. The oftener the material is passed between these rolls the better it is worked and the more continuous becomes the band of material.

After a large number of passes through these sheeting rolls, the band is cut apart and taken to the drying room where it is hung in the dark for a sufficient length of time to make it perfectly dry. In practice it is found that the process of washing or soaking and the subsequent masticating and sheeting have caused a loss in weight of material of from 10 to 40 per cent., depending upon the kind of gum. This loss is due to the removal of impurities, such as dirt, clay, pieces of wood, etc. The drying is done in darkened rooms because light has a chemical action upon the gum at this stage.

Mixing

After being thoroughly dried, the sheeted gum is passed through a set of rolls which are heated by steam and the surfaces of which are smooth, without either projections or corrugations. These rolls, however, travel at different speeds as before, and by passing the sheets of gum between them the material is thoroughly worked and kneaded and acts, in fact, very much like an exceedingly sticky form of dough. The gum sheets are bunched together and passed through the two rolls in lumps, the action of the rolls being to squeeze and draw out these

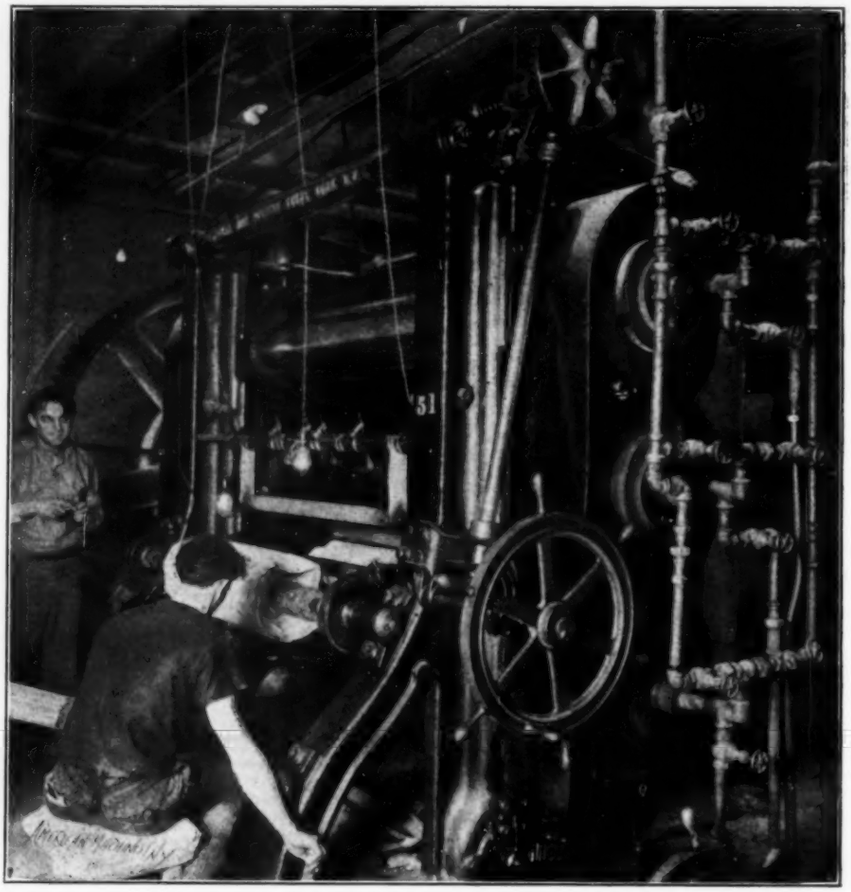


FIG. 3. THE CALENDER ROLLS. REELING OFF THE RUBBER STRIPS

lumps into a wide sheet. The material is very sticky and the steam-heated rolls make it even more so, so that as it passes through and is kneaded and worked by the action of the two rolls traveling at different speeds, it crackles and snaps and draws in quite a remarkable manner.

The operator, as with the sheeting machine, reaches down and draws up the end of the band of gum which is passed through the rolls and feeds it in again through the top making, as before, an endless band. By the action of the heat and the smooth surface of the rolls, this band of gum is very much smoother than the product of the first sheeting machine. In fact it does not resemble a sponge in any way at this stage.

As the gum band, which will be three or four feet wide, becomes fairly continuous, the operator makes a knife cut across the band as the rolls slowly revolve, this cut reaching not quite to the farther edge of the band. He then folds back the loose edge in a diagonal fold and allows this double thickness of material to be forced, squeezed and torn through between the revolving rolls. This further assists in the thorough working and kneading of the fibers so as to make the gum uniform, plastic and elastic.

It is on rolls of this character also that the mixing is done; that is, the chemicals which go to make the final vulcanized product, the principal chemical of which is sulphur, are mixed with the gum. This mixing is continued until it is assured that the chemicals are thoroughly and evenly distributed throughout the mass. These vulcanizing chemicals, that is, their proportions, are what constitute one of the secrets in the successful manufacture of rubber, and the particular chemicals used and their proportions depend upon the kind of rubber which it is desired to turn out. It is generally understood that this method of vulcanizing, that is, by mixing in dry chemicals, mostly sulphur, and the application of heat and pressure, was invented by the original Goodyear, who made most of the extensive experiments when the rubber business was very young and largely discredited.

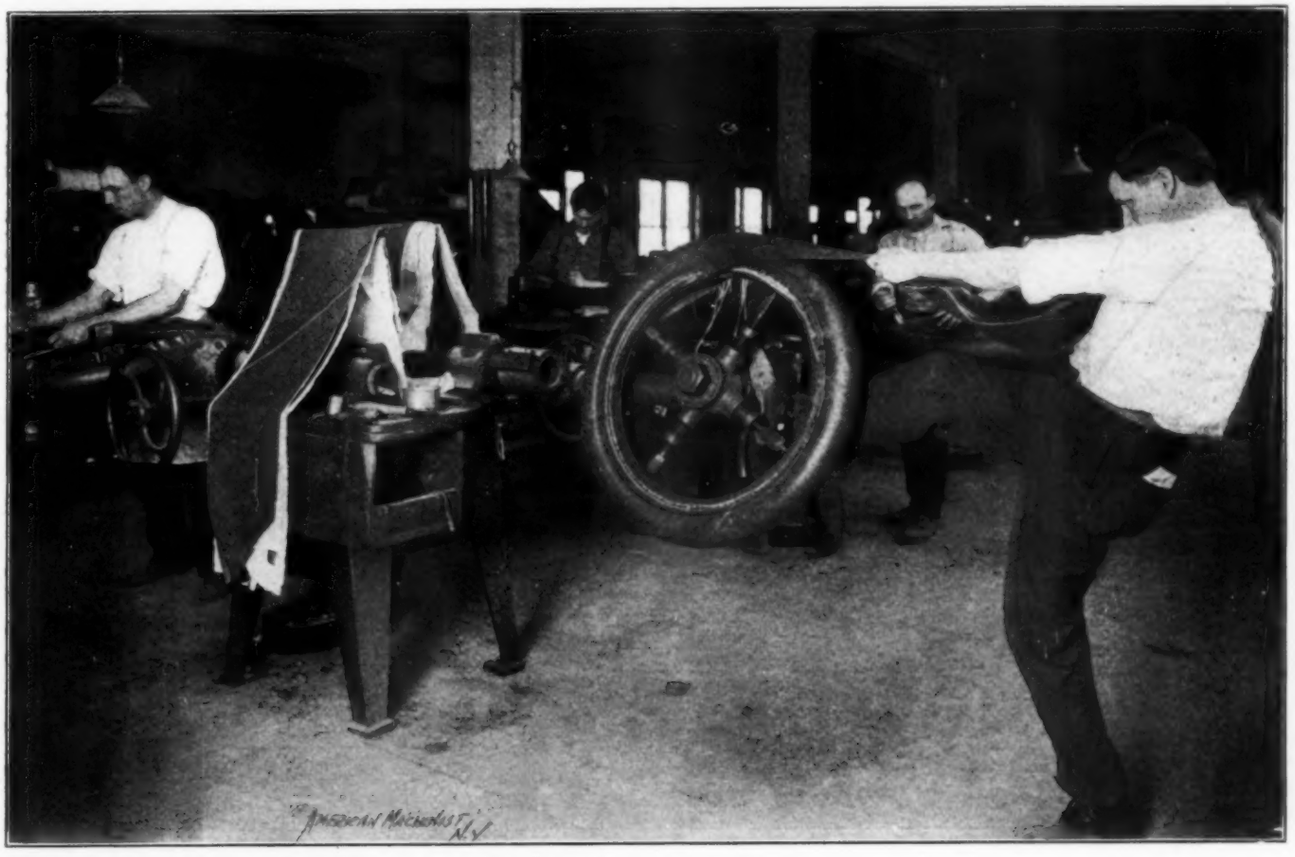


FIG. 4. A "HAND-MADE" TIRE. STRETCHING THE FABRIC

Calendering

Following the thorough mixing, the rubber gum is passed through the calender rolls, which are shown in Fig. 3. These rolls revolve at slow speed and again are steam-heated. It will be seen by the halftone that there are three rolls, one above the other, and in order to understand the action of the machine, it should be understood that the upper roll revolves in a clockwise direction as viewed on the end in the halftone. The middle roll viewed in the same way revolves in a counter-clockwise direction, while, of course, the bottom roll again revolves clockwise. All three of these rolls revolve at the same speed. The object of these rolls is to draw out the rubber gum containing the vulcanizing materials into thin sheets. In order to do this, the mass coming from the mixing rolls is thrown into the space between the top and middle calender rolls and in its present condition the mass is exceedingly sticky.

As the rolls revolve the mass of sticky gum is drawn between them in a thin sheet, while the bulk of the material remains behind sticking to the two revolving rolls, boiling over itself and crackling and snapping in a manner which it is impossible to describe and which is probably done by no other material besides rubber gum. It seems strange that the whole mass is not drawn through at once, nevertheless it is a fact that the rubber which comes out on the other side of the rolls, which is the near side shown in Fig. 3, is a very thin, smooth and even strip of material which is, of course, very sticky and which consequently sticks to the surface of the middle calender roll. As it travels around this roll, it is cut into strips of the desired width by means of knives which are shown in the halftone attached to a cross bar in front of the middle roll.

Passing around this roll it goes in again between the middle and bottom rolls, around the latter and finally out in front of the operator who is shown sitting

down. By the adjustment of the calender rolls rubber gum of any desired thickness may be made and although the material is so sticky and so difficult to handle, it is possible to gage the thickness of these sheets to very accurate dimensions and to make them very thin indeed.

In order to handle this delicate and exceedingly sticky gum in the shape of strips, it is reeled off from the calender rolls between sheets of cotton cloth. A reel of this cotton cloth is shown almost in the center of Fig. 3 and at the bottom, to the left, is seen another strip of it coming from a second reel outside of the picture. By reeling off the thin gum strips between layers of cloth, the strips are easily handled and transported and prevented from being torn or from accumulating dirt on their very sticky surfaces. When desired it is an easy matter to unreel these rolls of cloth and to separate the gum from the cotton.

Fabricated Rubber

Besides making these strips of rubber, these rolls are used for forming fabricated rubber, that is a kind of canvas permeated with the rubber gum and having one side composed of the fabric and one side of rubber. The nature of this material is easily recognized upon examining the inside and outside surfaces of an automobile or bicycle tire where the fabric surface is plainly seen on the inside while the rubber is on the outside.

To produce this fabric, long strips of the canvas, which have been previously coated on the opposite side with a certain kind of rubber cement, are fed through between the middle and bottom calender rolls in such a way that the rubber gum adhering to the second or middle roll is squeezed down upon this canvas and caused to thoroughly permeate it and become firmly adhered thereto. Underneath the bottom roll the fabricated rubber, that is the canvas permeated with the rubber coating, is reeled off between strips of the cotton material already spoken of and it is this operation which is being performed in Fig. 3 where the dark strip of rubber fabric, shown as coming from underneath the bottom roll, is being wound up by the operator in a roll of the white material which is seen coming from the left side of the picture.

It is this fabricated rubber which is used to make up the outer cases of the automobile tires. The fabric is taken to large tables where it is cut on the bias into strips about 18 inches wide and 5 feet long. These bias strips are next overlapped end to end in series so as to make a long strip, and in order to facilitate handling they are carried about on the strips of cotton goods before spoken of. In Fig. 4 at the left center will be seen several sheets of this bias material hanging over racks ready to be made into tire casings.

Hand Made Tires

To make the outer casings of the tires by the old hand method the illustration in Fig. 4 will give a very clear idea. A cast-iron core is fastened onto an arbor which is free to revolve like a wheel on an axis and this axis may in turn be rotated in a plane perpendicular to the plane of the core or wheel. The arbor may be prevented from rotating in one direction by means of a ratchet on its axis and the axis itself may be clamped so that it cannot be turned in its own plane of rotation.

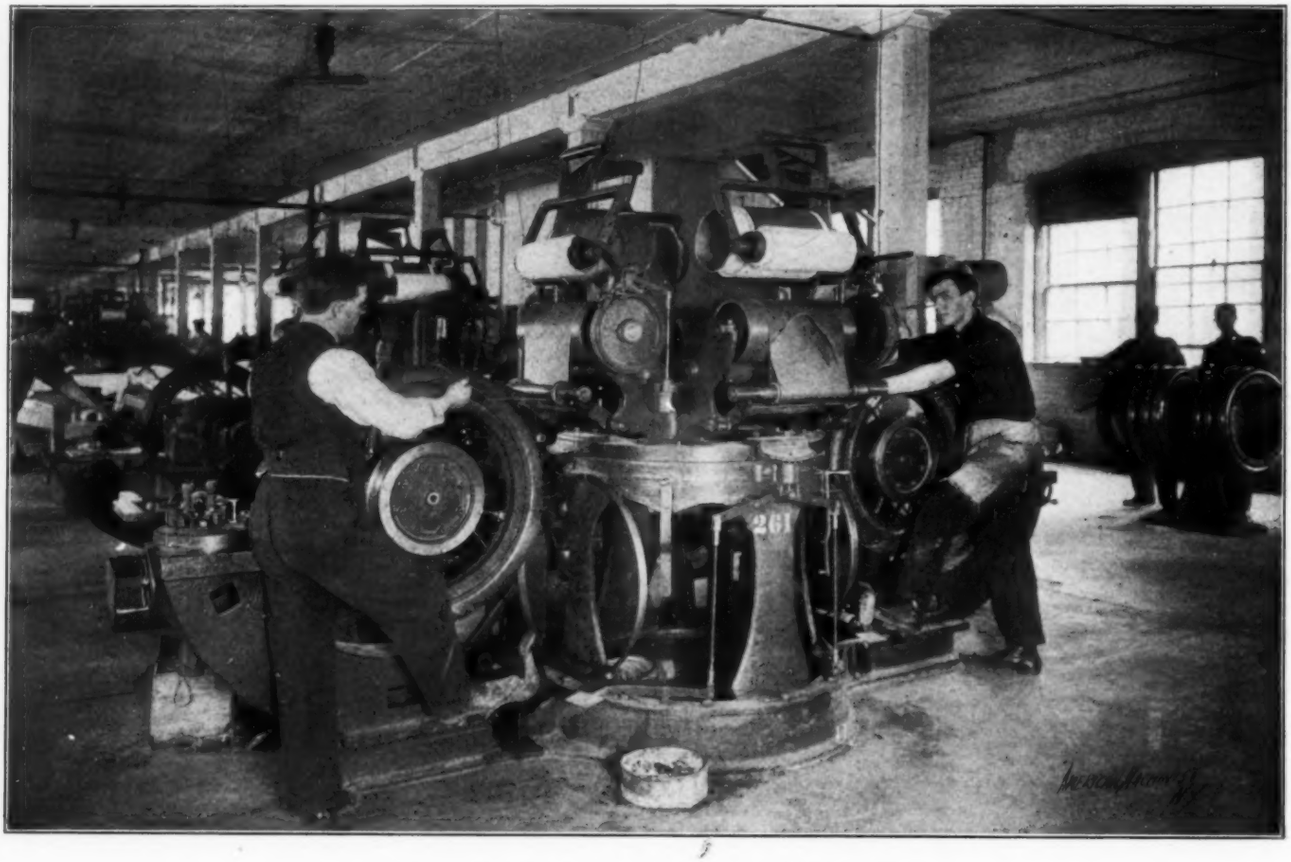


FIG. 5. A MACHINE-MADE TIRE. STRETCHING THE FABRIC

It must be understood that the fabricated rubber is very sticky and it is this characteristic which enables the operator to fasten the strips together on the bias edges simply by laying them together and applying a little pressure, so as to form a long strip of several short strips.

The first operation of building up a tire casing, or shoe, as autoists would call it, is to coat the surface of the core with a special kind of cement to make it sticky. Next the operator throws over his shoulder a strip of the fabricated rubber, while he lays one end of the strip tightly down on the core. Due to the general stickiness of the material itself and also

to the cement with which he has coated the core, the fabric adheres very strongly to the cast iron and then by main strength, as vividly shown in Fig. 4, the operator draws the fabric around the core, using his utmost endeavor to put a uniform stretch throughout the material as it is drawn around.

It may occur to the reader to ask why the material does not wrinkle and crumple up as it appears that the flat strip of goods is laid around the circular section and bent in two directions. The answer to this is that the material, being cut on the bias, with a little persuasion will lie smoothly down all over the surface of the core. It will be understood, of course, that as the operator draws the material around the core, the latter is rotated a little at a time by hand so as to wind up the material, the ratchet on the axis acting to keep the core from turning toward him when he is drawing the material or putting in the stretch. Two, three or four layers and possibly more of the material are laid one above the other and the ends are overlapped, forming a complete circle of the tire, care, of course, being taken that the overlaps do not come opposite one another in the different layers so as to make a rough place in the tire.

During the process of building up, the beading is put in around the rim which nearly always exists in an automobile tire to assist in fastening the outer casing to the rim of the wheel. This beading is simply laid in between the folds and the material itself is tucked and folded around the beading. By considerable coaxing it is caused to lie smoothly without any wrinkles and its general sticky nature helps in holding the different layers and the folds together in a very neat manner. It should be said that the beading itself is a ring of rubber material very often containing a braided wire center in order to give it stiffness.

FIG. 7. THE "BANDAGING" MACHINE

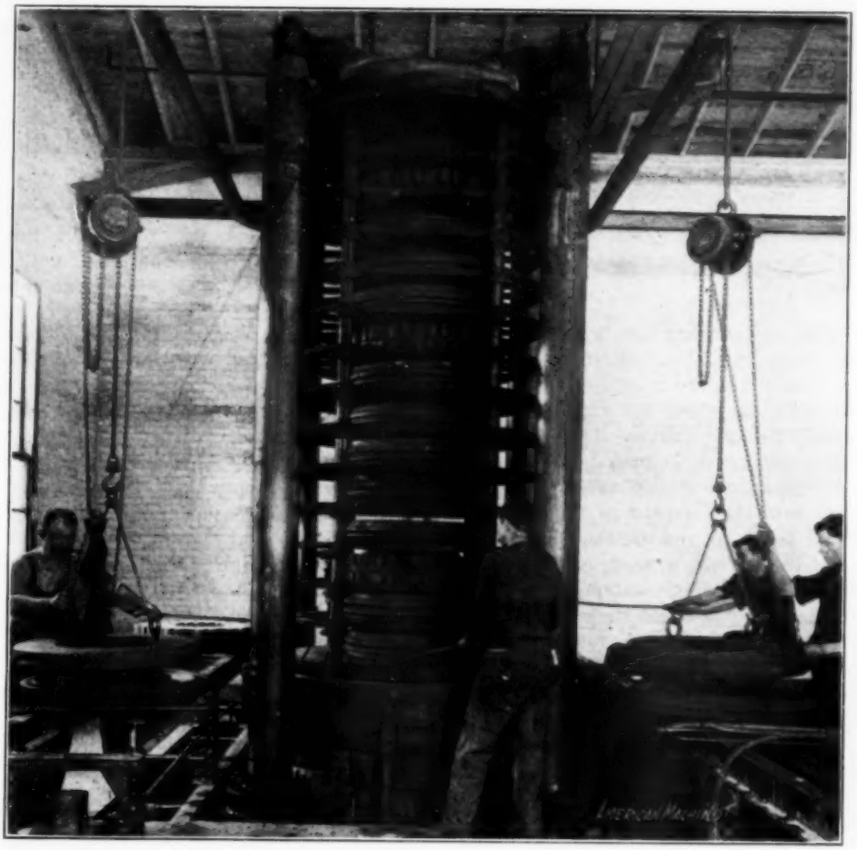


FIG. 6. THE VULCANIZING PRESS AND MOLDS

At the left of Fig. 4 and also at the right center of the picture just beyond the hands of the operator who is drawing the rubber material, can be seen two other operators who are folding down the strips of fabric around the beading at the rim, and it is seen that each is using an instrument consisting of a small disk wheel mounted in a handle which he rolls around the fabric causing it to lie smoothly down over the beading. In order to assist in making the tire strong, special strips of fabric are laid around near the rim, which act as reinforcements, thus holding the parts together.

Machine Made Tires

So much for hand-made tires. The objection to the hand-made tire is the fact that the amount of stretch given by the operator is anything but uniform as he gradually pulls the material around the core a short stretch at a time. Also as the day goes on, he naturally becomes wearied

and the tires which he makes at the end of the day do not have as much stretch as those which he makes at the beginning of the day and in all probability will not be as good.

In order to obviate these sources of irregularity, the Goodyear Company has gotten up the machine illustrated in Figs. 1 and 5. As will be seen, in the center of this machine is a revolving turret which contains four rolls of fabricated rubber material which is to be made into the outer casings of the tires. In the top rolls is seen the cotton cloth which comes from the calender with the fabricated rubber and which is reeled off and separated from the fabric onto a small roll which contains only the cotton itself. The rubber fabric passes down and around several rolls whose office it is to give the proper tension to the material.

The central turret with its rolls is mounted on a ball-bearing spindle and may be rotated so as to bring the different rolls opposite the two different operators who handle one machine. Suitable locking devices are provided to hold the turret in any one position. The object of having so many rolls of material is that the layers going to make up the tire are cut on the opposite bias in adjacent layers so as to give uniform strength in all directions to the tire. Thus after each of the two operators has put on a layer of one bias from the roll of material in front of each, the revolving head is turned 90 degrees and the operators then reel off the material for the next layer cut on the opposite bias. In this way neither of the two operators has to wait for the other one because each is provided with a roll for himself on each bias.

In this machine it will be seen that the same core is used as with hand work, but this core is mounted on an axis which may be turned by power and which is provided with two speeds of rotation. The first operation is as before to apply the cement to the surface of the core and then to draw out the fabric as shown on the left side of the machine in Fig. 5. The end of the strip is carefully pressed down upon the cemented core so as to make it adhere firmly and then the slow-speed rotation is applied to the core itself. This rotation draws out the fabric, the correct and uniform tension being given to the fabric by the rolls mounted on the central turret of the machine, which tension is adjustable by means of weighted brake bands. After each layer has been thus accurately laid on, the material is cut off on the bias, the ends of the strips on the core being lapped over and pressed down so as to make a continuous band. After this the operation shown in Fig. 1 follows.

Here a lathe-like attachment on the machine is brought into operation. The core is now revolved at high speed by the power mechanism and, by means of the hand wheel shown on what may be termed a tool rest, various rollers and formers are brought into action which press the fabric tightly together in its various layers and which fold it down over the sides of the core, making it lie flat in a smooth and continuous surface.

At the left of Fig. 1 the operation of rolling in the beading around the rim is seen. By the adjustment of the toolholder to an index mark, the correct diameter for the beading is insured and its rolling in is a matter of but a moment, and is, of course, accurate. By means of this machine an operator may make four or five tire casings while one is being made by hand by the old method, and at the same time it is clearly seen that the machine-made product is uniform in tension in all its layers and in all parts of its circumference. The machine also smoothly and evenly rolls down the layers upon themselves and the core, making a far superior job as compared with the hand-made tire.

FIG. 8. MAKING THE INNER TUBES ENDLESS

Molding and Vulcanizing

After the beading has been put in and the edges tucked down and reinforced, the core is removed from the central arbor and with its fabric and rubber covering is placed in a mold, as shown in Fig. 6. When the cover is placed on the mold over the core and the rubber fabric, the application of pressure to the two sides of the mold will squeeze the rubber fabric tightly and a pile is made of these molds in a hydraulic-press vulcanizer, as shown in Fig. 6. After the shelves have been filled with the molds, each containing an unvulcanized tire with its cast-iron core, the whole framework is allowed to drop down into a large cylinder and by means of the hydraulic rams heavy pressure is put upon the molds.

While this pressure is being exerted, steam at about 275 degrees Fahrenheit is blown into the vulcanizing vessel and the action of the heat causes a chemical combination between the rubber and the sulphur and other chemicals of the vulcanizing material. Also the pressure of the mold makes the different layers of the tire fabric stick tightly together and knit into practically one fabric, while the rubber loses its sticky nature and becomes what we know as vulcanized rubber.

The process of vulcanization is not completed in these molds, for as yet the tires are not provided with the outer coating or tread. This tread is an extra thickness of rubber which is put around the running surface of the tire and which often carries small metal disks or rings, or corrugations and projections in the rubber such as are frequently seen on automobile tires. These treads are made from the thin strips of rubber gum which were first described as coming from the calender presses. They are laid together in layers while still unvulcanized, and by means of special molds they have the metallic parts incorporated in them, or the small rubber projections, corrugations and ridges are raised by means of a mold while this tread is being semi-vulcanized in a manner similar to the first process of vulcanization of the main tire, as described and illustrated in Fig. 6.

Putting on the Tread

In order to apply the semi-vulcanized treads to the semi-vulcanized tire a layer of rubber cement is applied to the outside of the semi-vulcanized tire, this cement being largely unvulcanized rubber in its make-up. The tread is then laid on the outside and bound to the tire by means of strips of cloth. It should be said first, however, that the cast-iron core which was in the casing of the tire during the process of vulcanizing in the hydraulic press is removed. Its place is taken in the tire casing by what is known as the air bag which in reality is an inner tube which will hold air under pressure. This wind bag holds the tire stiff and yet some-

what flexible, while around the circumference there is applied the strip of semi-vulcanized rubber forming the tread.

Bandaging by Machinery

Fig. 7 shows the machine which is used to bind the strip of cloth around the tire casing which contains in its interior the wind bag and around its circumference the tread which it is desired to cement and vulcanize to the main tire. The machine shown in Fig. 7, it will be seen, consists essentially of a gear wheel without any spokes or hub, it being carried and guided on its circumference by means of rollers in the frame of the machine. This spokeless gear wheel carries on its rim a reel about 8 inches in diameter which has the cloth strips wound upon it not greatly unlike the long rolls of bandage used in a hospital, although, of course, it is not sticky. This bandage material is, however, wet when it is applied, and its application is accomplished by the rotation of the spokeless gear wheel carrying the reel round and round through the circular tire and at the same time, by means of the vertical rollers which guide the tire, the latter is rotated on what would be the axis of the automobile wheel were it in place. In this way the cloth bandage is tightly laid on in a very wet condition.

The next step is to take this bandaged tire with its wind bag and tread to another steam tank where the vulcanization is completed and the tire and tread are made practically into one piece. The action of the heat, of course, expands the air in the wind bag and as all the stretch has been taken out of the wet bandage cloth, the expansion of the air in the wind bag puts a very heavy pressure on the rubber of the casing and tends strongly to knit the parts together; that is, to make one piece out of the main tire and its tread.

It should have been said that during the first process of vulcanization in the cast-iron mold, shown in Fig. 6, the various letters, usually of a raised character, which appear on the side of a new automobile tire are formed; their forming is, of course, due simply to the tendency of the rubber to expand into the spaces cut for the letters in the mold itself. These letters and, in fact, any marks which may be put on the mold, come out in a very sharp, clear manner characteristic of molded rubber.

The Inner Tubes

This, then, practically describes the making of the outer casing of automobile tires. The inner tubes are very simply made and their production is at present almost entirely hand work. The rubber gum coming from the calender presses without fabric is cut into the proper width and the edges scarfed or chamfered. These edges are then overlapped upon each other and raw or unvulcanized rubber has a strong tendency to stick together, in fact, forming one piece of material when pressed tightly together. This pressing is done by hand, a stick of lath being inside of the folded strip of rubber upon which to press the seam of the tube.

In this form, of course, the inner tube is a straight piece having two ends somewhat like a short length of thin rubber hose. In this condition it is slipped over long metal tubes or forms, and in order to facilitate sliding it over the tubes compressed air is applied to one end of the rubber tubing which tends, of course, to expand the latter and allows it to slip over the metal vulcanizing form or tube very easily. These long forms are then wrapped with cotton bandage cloth and put into vulcanizing tanks where, by the application of heat by means of steam, the sulphur is again combined with the rubber gum forming the well-known vulcanized rubber inner tube which is, however, still in the straight shape.

In order to make the tube endless a very ingenious device is used. Fig. 8 shows that the tubes have slipped over one of their ends a metallic sleeve. This sleeve is really double, and in the space between its inner and outer walls another sleeve fits very neatly. The rubber of the inner tube is folded down over the end of one of these short sections of metal tube, the surface of the rubber being treated with curing acid to make it raw and easily cemented. Next the other section of tube is slipped down into the first section and by the application of compressed air the two sections are practically shot apart, causing the turned-back section of the rubber tubing to slide over the other end and lie flat upon it. By the application of rubber bands around the outside of the joined portion sufficient pressure is brought upon the parts to cause them to stick together. The metallic tubes are removed from the now endless rubber tube by sliding the rubber out through a groove which goes down one side of each one of the metal tubes.

An Interesting Gas Engine

An interesting development of the gasolene engine has been applied to railroad hand cars for the use of section men by Fairbanks, Morse & Co. This takes the form of a 5-horsepower, air-cooled, two-cycle gasolene engine, which will run equally well in either direction. The hand-car is started either way as desired by the regular hand levers, which are disconnected as soon as the motor is started. In case of mishap of any kind the motor can be easily disconnected and the car propelled by hand in the usual way.

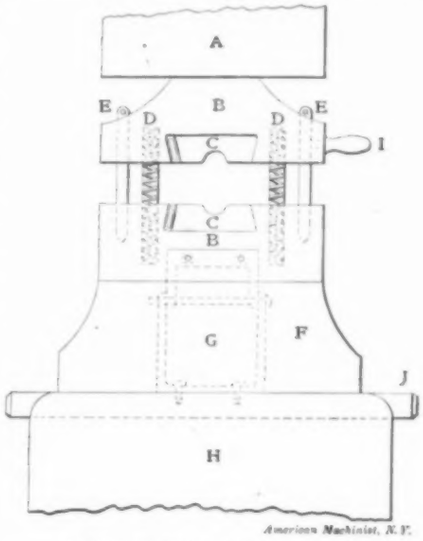
A very interesting feature which adds greatly to the simplicity of the whole mechanism is the way in which the engine is lubricated. Both the lubricating oil and the gasolene are put into the same tank, ¾ pint of lubricating oil being thoroughly mixed by shaking, with 1 gallon of gasolene. In this way the lubricating oil goes into the crank case and cylinder with the gasolene, and the makers claim that exhaustive tests have shown this to be a positive and thorough method of lubrication.

Fixture for Steam Hammers

By James Cran

The accompanying illustration shows a fixture that can be attached to the ordinary steam hammer and can then be used for making drop forgings, open-die forgings, or for swaging round work without removing ordinary dies, or without breaking up the hammer for ordinary blacksmith work.

In the sketch *A* is the top die of the hammer; *B B* machinery-steel die holders; *C C* tool-steel dies or swages; *D D* spiral



A USEFUL FIXTURE FOR STEAM HAMMER

springs for ordinary dies; *E E* guide pins for keeping dies in alinement; *F* bottom die of hammer; *G* jointed hinge connecting die holder to chair of hammer (it can be folded back out of the way when not in use); *H* chair of hammer; *I* handle for folding back fixture, and *J* the key for keeping lower die in position.

The following test, which can be made by anyone with simple apparatus, is recommended for detecting acidity of lubricating oil by the *Horseless Age*. Procure from the druggist a solution of sodium carbonate in an equal weight of water. Take a small quantity of the oil and an equal amount of the sodium solution. Place them in a bottle, shake, then allow to stand. If there is any acid present it will settle to the bottom as a precipitate, the amount of precipitation indicating the amount of acid present.

Buying Carbon Tool Steel on Specifications*

By J. M. Darke

Three years ago the writer conceived the idea of buying carbon tool steel on a specification basis, in the same manner as many other materials used by large manufacturing concerns are purchased. When the subject was broached to those most interested, it was received with little enthusiasm. The manufacturers of carbon tool steel were not in favor of the idea, as it removed at once the value of their brand of trade names, upon which they had spent years of advertising, and which represented the real difference between their steel and the steel made by competitors. The master mechanics and shop foremen were somewhat doubtful as to its success, as the idea was so radically different from the system under which they had been working for years. Many of them were men of long experience who had used certain brands of steel for years, and it seemed impossible to them that there were dozens of other brands equally good. It is also natural to feel that in adopting a scheme which removes the responsibility of making a choice in selecting steel, something quite personal has been lost.

Others objected to the idea on the ground that "chemical analysis was not the whole thing." This is true in a narrow sense. This same argument was advanced when the chemist was introduced into iron and steel foundries and various other industries. Through the lack of exercising ordinary common sense, the chemist came very near being an absolute failure in the iron-foundry business. This would be the outcome if chemistry were applied in the same manner to a tool-steel specification. Chemistry properly applied is a great aid in determining the quality of tool steel, but it will not tell whether the steel was made in an open-hearth furnace or a crucible. The microscope will answer questions that chemistry cannot. The specification was, therefore, drafted to include both chemical and microscopical analysis.

A large number of American manufacturers of carbon tool steel were asked to submit samples representing their various brands. These samples were carefully analyzed, photomicrographs were made, and results compared. It was found that the steels grouped themselves into three grades, one about a 7-cent base, the second about a 14-cent base, and the third about a 22-cent base; the latter usually being a "double special" steel, and generally containing some alloy.

The various tool-steel mills were visited by a committee, including the writer, and as representatives of a large consumer of tool steel, we were afforded exceptional facilities for investigating the plants. We found that all the mills visited were well equipped, both in men and apparatus, for making good tool steel, and that they were honestly trying to maintain a high standard. In short, there was no reason why any one of the mills visited could not produce as good steel as its neighbor.

With the above facts in mind, the following specification was drawn up and presented to the trade:

Specification for Carbon Tool Steel

(1) Tool steel to fill this specification will be required in five classes and three grades, as follows:

Class No. 1 . . . . . 0.75% to 0.85% carbon.
Class No. 2 . . . . . 0.85% to 0.95% carbon.
Class No. 3 . . . . . 0.95% to 1.10% carbon.
Class No. 4 . . . . . 1.10% to 1.25% carbon.
Class No. 5 . . . . . 1.25% to 1.40% carbon.

	Grade "A."	Grade "B."	Grade "C."
Manganese	0.25% to 0.45%	0.25% to 0.35%	0.25% to 0.35%
Silicon, not over.	0.20%	0.15%	0.12%
Phosphorus, not over	0.03%	0.020%	0.010%
Sulphur, not over	0.04%	0.020%	0.010%

	Grade "A."	Grade "B."	Grade "C."
Class 1 0.75 to 0.85 C.	Drop dies Dies for hammers in blacksmith shop	Hammers Drifts Punches Hot chisels	Cold chisels Cold sets
Class 2 0.85 to 0.95 C.	Cams		
Class 3 0.95 to 1.10 C.	Sheet steel for springs	Lathe centers	Miscellaneous steel for blacksmith shop
Class 4 1.10 to 1.25 C.	Spring (coil)	Springs (Spec.)	Miscellaneous steel for die room Large reamers Sheet steel for slotting saws Large dies Large taps Letters Figures Milling cutters (over 2" diameter) Drill rod
Class 5 1.25 to 1.40 C.			Milling cutters 2" under Small dies Chasers Gravers Dies for heading machines

TABLE GIVING CLASS AND GRADE OF TOOL STEEL FOR VARIOUS PURPOSES.

(2) The steel to be crucible steel properly melted in crucibles, not so-called "crucible analysis," with the exception of grade "A," which may be acid open-hearth steel.

(3) The steel shall have been sufficiently forged to refine the grain, and forging stopped at such a temperature that the maximum refinement of grain will be obtained.

(4) Steel containing the exact minimum amount of carbon in any class will be considered as belonging to the class below.

(5) The steel shall be free from flaws and other imperfections.

The 22-cent grade of steel was discarded; being an alloy steel, it could not be included in a carbon-steel specification. A very low-grade was added to cover such steel as would be suitable in open-hearth.

The various manufacturers were asked to quote prices on the different grades, which, with one or two exceptions, was done.

As an aid to the application of the specification, the accompanying table, giving the class and grade of steel for various purposes was compiled. Such parts are omitted as are not of general interest.

This table was compiled by a tool-steel committee composed of representative men from the departments using tool steel. Each article was fully and carefully considered and many of the selections (not appearing in table as printed) were the result of extended practical trials made in the shop under the supervision of a member of the committee. Valuable suggestions received from tool-steel manufacturers were also incorporated. The table is subject to revision as experience renders necessary. New copies are issued to department heads and shop foremen whenever changes are made.

When tool steel is required by the various departments, requests for same are placed by the heads of departments with the stock and order department. These requests, or orders, are then referred to the laboratory department to insure that the proper class and grade of steel is specified for the work in hand. The orders are entered in a record book, O. K'd, and returned to the stock and order department for placing with the steel manufacturer. A copy of the requisition as placed with the steel manufacturer is also kept on file in the laboratory.

The tool steel is received by the receiving department, who notify the chemical laboratory and the shop foreman for whom the steel is ordered. The date of receipt is entered in the record book in the laboratory.

The shop foreman upon receiving the

*From the *General Electric Review.*

steel, cuts off small samples, or, in case of large bars, takes drillings and sends them to the laboratory properly marked. Analysis for carbon, phosphorus and sulphur is then made, and if according to specifications, the shop foreman receives a copy of the analysis, which constitutes a release and the steel may be used. If not in accordance with specification, the inspection department is notified and the steel is rejected. Making the necessary records and analyses occupies very little time, and costs on an average 50 cents per sample.

A brief statement of methods employed in the chemical analyses may be of interest.

The carbon is determined by direct combustion of the drillings in a platinum tube, and requires 15 minutes time.

The phosphorus is determined by the Jones reductor method, and requires about 30 minutes.

The sulphur is determined by the iodine-titration method, and requires about 30 minutes.

One operator can make several phosphorus or sulphur determinations in very little more time than is required for one determination.

Silicon tests are made occasionally and require three hours' time, only a small portion of the work demanding the chemist's attention.

Microscopical examinations were made frequently when the specifications were first adopted, but it was found that the steel ran so uniformly good in this respect that now the examinations are made only occasionally. This would be the first test made, however, in case of trouble.

The steel is received without labels, but each bar is stamped with its class and grade, and the symbol designating the maker. For instance, steel of Class 5, Grade C, ordered from the Crucible Steel Company of America would bear the stamp when received, 5-C-A; of Grade B, 5-B-A, etc.

Before adopting this specification we had 109 brands of steel listed, ranging in price from 7 to 35 cents per pound, any one or all of which might be in the factories at any time. The individual shop foreman decided whether he would use one or the other. It was impossible to keep all these brands separate, and the brand was no guarantee that the carbon content would be right for a given purpose. We were apt to get a high-carbon steel for a hammer and a low-carbon steel for a milling cutter, as all tempers were carried in the same brand.

The specification has greatly simplified stock keeping, as now five classes and two grades cover 98 per cent. of our requirements. We have uniformity of product and a considerable assurance that the steel contains the right amount of carbon to render maximum service when used for the purpose for which it is intended. This is due to the fact that the selection of steel is governed by the table before referred to, entitled "Table Giving Class and Grade of Tool Steel for Various Purposes."

As there are only three grades of steel called for in the specification, we have only three base prices. This gives a uniformity of prices and a definite basis for figuring costs.

The failures in hardening have been reduced to a minimum, because the hardeners know from the class of the steel the amount of carbon contained, and, therefore, the proper annealing and hardening heats. With furnaces properly equipped with pyrometers, and the carbon content of the steel known, most of the elements of failure in hardening have been removed.

While the primary object of the specification was to secure uniformity, it has considerably reduced the total cost of tool steel. This reduction of cost has been obtained, not only by competitive bidding on the specification, but by selecting high-priced steel only where it was needed. The total saving cannot be readily determined, since so many factors enter into the calculation, such as increased life of tools and less breakage in hardening of parts involving large amounts of labor.

Specifications in general do not afford absolute protection against fraud, and are not so intended. They serve to standardize the article and describe to sellers just what the purchaser wants. If the material received is tested and does not measure up to the specification, it can be rejected without undue controversy. A tool-steel specification does not differ in this respect from other specifications. During an actual trial of this specification for one year and three months we have found no disposition on the part of tool-steel manufacturers to ship inferior steel. They are just as anxious as we are to have their steel a success, and work to the spirit of the specification as well as to the letter.

The success of a specification of this kind depends more on the make-up of the organization using it than on the seller. The organization must be in thorough sympathy with the ideals sought, or the plan will be a dismal failure. Prejudice in favor of certain brands and all petty personal jealousies must be laid aside, or it cannot succeed. Fortunate, indeed, is the organization that encounters none of these. There are usually some old employees who resent an innovation and who prefer to follow in the footsteps of their fathers. If, however, the plan is accepted and used in the proper spirit and with judgment, it will be found to work to the mutual advantage of seller and buyer alike.

An Adjustable Angle Plate

By Elmer A. Ermold

The line cut shows an adjustable angle plate, which I designed and had made recently. As I have never seen anything like it in use and as it has answered the purpose so well, I thought it might be of interest to someone else. It is different from the ordinary hinged plate in several ways. First, when the top number is vertical it is in the middle of the base, so that any work clamped to it does not overhang. Second, when the top member is horizontal the hight over all is very much less. Third, and most important, for nearly all angular positions its rigidity does not entirely depend upon the friction of the clamping bolts as the edge of the top plate rests on the base, preventing it from swiveling about the bolt as a center. The large bosses are cored out to make them lighter, and also act as ribs to stiffen the plates, especially the top plate, which has the T-slot cut in it.

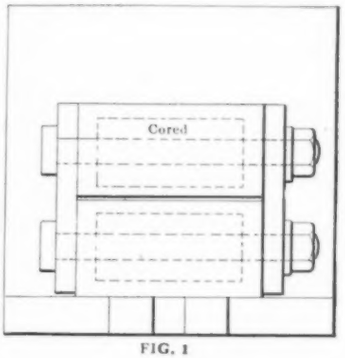


FIG. 1

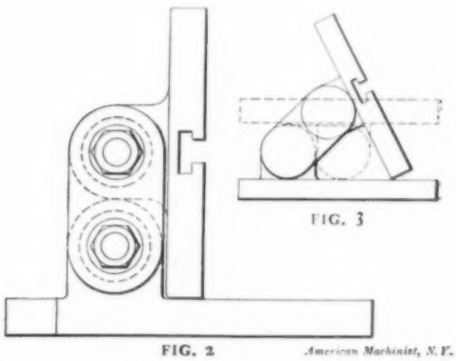


FIG. 3

FIG. 2

American Machinist, N.Y.

AN ADJUSTABLE ANGLE PLATE

Palladium, a rare metal usually associated with platinum and chiefly used in the manufacture of astronomical instruments and for dental purposes, was imported into this country during 1908 to the extent of 0.03 pound, valued at $21, a pound, therefore, being worth approximately $700. It is found in its native state in small quantities in Germany and Brazil principally.

The Premium System of Wage Payment*

Features of the Successful Use of the System by One, Who, While Optimistic Regarding It, Recognizes That Difficulties Attend Its Application

BY C. B. LORD†

In presenting this paper, I intend to treat it from the standpoint of the employer, superintendent or those in authority. While the interests of the employer and employee are to certain degree identical, it is well to have no false impressions on the subject where piece and premium rates are concerned.

Before going into the matter of the premium plan of increased earnings, let us for a moment review manufacturing methods as they have been and are still in the average factory—or even let us say in our best factories, with some few exceptions. The writer of an article on the premium plan in a recent issue of the AMERICAN MACHINIST makes the statement that "our best shops are not turning out over three-fourths of their capacity." A little thought will show that this estimate is conservative, and a study of the records will not only corroborate the estimate, but will also show that we did not know what our maximum was.

Labor is the most costly item in all manufacturing lines, or so nearly so that the statement is practically true, and still we are more prodigal of labor than we are of material. True, we figure whether this method or that method is the cheaper, and change our design to cheapen manufacture, but that is only comparative cheapening.

We have not, however, been able to cheapen labor by increasing the productive capacity of the workman to any appreciable extent by the day-work system. Automatic machines have been designed to increase output, and do so, but they have not increased the capacity of the man—quite the contrary; men are running three and four machines where they can run six—one, where they should run two.

The same applies to high-speed steels and high-power machine tools. Only about 40 per cent. of the jobs in the average factory that are using high-speed steels need them; in some cases this is the fault of the man, in others the fault of the machine.

The foregoing being true, it is evident that it was desirable, even necessary, to evolve some scheme to speed up the workman. In bygone days this was very simply and ineffectively done by the foreman cussing the men up hill and down. The benefit derived from this, however, was very doubtful, and the foreman doing this was known as a "driver." The "driver" is now obsolete, and we have arrived at the age of the dignity of labor, but "dignity" will not labor without an incentive.

It being inadvisable and practically impossible to force work, employers began to cast about for means of inducing it. Almost any clerk of average intelligence can sit down and figure out a working system, and tell how it should work mechanically, but it requires an executive having a wide experience with mankind to tell how it will actually work out. If only the mechanical working were required, our path would be quite easy; but we must take into consideration the prejudices of the mass, the forgetfulness of the many and the cussedness of the few. These three equations make the wisest of us stand still and scratch our heads to find the answer.

The first step in evolution was naturally the piece-work system. This has been found very satisfactory where muscular effort predominates, or upon work where a low grade of intelligence is required. In my estimation it is an excellent method of compensating such work as shoveling coal or dirt, unloading or wheeling pig iron, bricks, ore, and along similar lines. In work of this kind there is no danger of the overhead operating expense being unduly increased as the man's productive power increases. Moreover, a man is responsible by the exercise of his own muscle for any increase in his output, and owes no thanks to any machine for helping him.

Owing to certain abuses, not entirely the fault of the system, piece work has fallen into some disrepute, except, oddly enough, with very large firms. In response to the demand for a substitute, the premium system was evolved by F. A. Halsey, editor of the AMERICAN MACHINIST—and the differential piece rate by F. W. Taylor, likewise several modifications of the three, giving quite a number to choose from.

The great drawback, however, in choosing any system, seems to be that we find ourselves unable to choose a middle course, or to use more than one system. It seems inconsistent to use day work, piece work and the premium system together, but at times they dovetail very nicely. One would think that with the manufacturing business as old as it is we would have some definite system, the principles of which would be almost universally applicable. It is my opinion that one of the reasons why we have not this is that we have tried to have the different systems evolved, like charity, cover a multitude of factory sins. We have pieced them, cut them, expanded them and compressed them, trying to make them cover every possible variation and condition. The result has been that they are full of holes and have been strained so much at the seams that they have been discarded as useless. We are not liable to introduce any system unless it is superior to the system, or lack of system, it succeeds, and is necessary, or desirable, to cure abuse or lessen expense. In nine cases out of ten the abuse of any system has been on the side of the employee, so that the inauguration of a new one may appear to the unthinking a scheme to reduce prices, and in some cases will be resented unless handled very diplomatically.

If we can use but one system, it should of course, be the one that will take care of the greatest number of our necessities, and do so in a way that will safeguard the employer's interests and be just to the employee.

FAIREST AND MOST EQUITABLE SYSTEM

Having had experience with piece price, bonus and premium systems in large plants, I am prepared to state that the premium system is the fairest and most equitable, as well as the one that most nearly fills the requirements. My reasons for this statement are:

First. It allows for the setting of a single allowance for each operation that takes care of every employee, from the boy to the mechanic, and distributes the premium in exact ratio of their comparative abilities.

Second. It is much easier and more accurate to estimate in minutes the time it should take to do a certain operation than it is to translate this into money values, for we very soon lose sight of the minutes and say, "Oh! I guess that is worth about 15 cents, one with a smaller diameter pays 12 cents." If we reckoned in minutes we would stop to analyze the operations and probably recognize that a considerable range in diameter, say on shaft work, makes very little difference in the actual working time. Also, when you tell a man, for instance, the price is 3 cents, it seems small to him; if you tell him it is 9 minutes, it seems larger and does not primarily suggest pay envelop—he figures that out afterward.

*A paper read at the annual meeting of the St. Louis branch of the National Metal Trades Association.

†Superintendent, Wagner Electric Manufacturing Company.

How Premium System is Employed Card Records

The system as employed at the Wagner Electric Manufacturing Company's plant is, in its essentials, as follows:

Card records of the different standard parts are kept, no matter whether done under day, piece or premium system. These cards show number of parts finished—total time consumed—average time, and cost, also operator's initials and number, and are primarily used for estimating costs, but serve as a check in setting allowances and as a guide as to what is being done in the matter of time consumed. I do not consider this an expense due to the premium system, because, if we have not the records we ought to have had them. Considerable discretion is required in keeping these, and records out of the ordinary should be proved.

The different operations, outside of actual laborer's work, are divided as far as possible into standard operations; for instance—in lathe work we have three operations—turning, facing and boring. This takes care of the outside, inside and ends; if two ends are to be faced, the operation states "facing two ends." This prevents confusion and ambiguity; if one operation is to be done, we say "turn" or "turn only;" if all operations are to be done, we specify "turn, face and bore" or "turn complete." If the article is to be finished in the lathe and requires no further operations, the card reads "finish complete." In this connection I wish to state that the lazy way of fixing premium allowances is to specify "finish complete" where other operations are to follow on other machines or elsewhere. This compels the man doing the job to do all the operations and follow the job through, thereby saving the foreman and clerks considerable trouble, but at the expense of output and cost. A given job can be done in much quicker time by being divided, and doing the operations one by one, than it can by having one man do them all successively.

Time Allowances

This leads up to the question of setting allowances and the method of doing it. Most of us think we can set piece prices or premium allowances accurately; as a matter of fact, we cannot. Someone has said that the only certain knowledge is the inspired guess, and the only true expert the inspired guesser. That being so, all that most of us lack, in order to qualify for an expert, is the inspiration—but what Edison said of invention is true of inspired guessing—it is one part inspiration and nine parts perspiration.

F. W. Taylor spent twenty years studying the lathe in its relation to cutting metal, and ten years in evolving a method of setting prices; he finally settled upon the method given in his "Art of Cutting Metal," in which a slide rule is used. This guessing stick, as some call it, has 12 variables, and there is used in conjunction with it another rule having 4; so that in setting premiums, if we would set them mathematically correct, we would have to take into consideration sixteen mechanical conditions. This being so, it can be seen what an advantage it is not to have to consider the personal element, which in most cases would upset all the other calculations.

Life is too short for the average man in authority to go into such details, and, as our general manager once remarked about another matter, we must either have a bank or a receiver behind us when we attempt to inaugurate such a system.

So the best we can do is the inspired guess, the inspiration being a knowledge of mechanical and shop conditions and an insight into human nature. There is nothing in which there is less glory and more trouble than setting allowances, although this disagreeable element is greatly reduced by the use of the premium system. The great danger to be fought against is the making of too liberal allowances, for, like the mother who indulges her child too much, the time arrives when she cannot control it, and then, instead of blaming herself she bewails the fate that gave her such an undutiful child.

That the fact of a premium allowance being based upon the time it took to do a similar operation under premium conditions carries little or no weight with the average man is demonstrated by the records, an instance of which I give—this being from the original record:

On 5/4/08 an allowance of 6 hours and 45 minutes was set for assembling coils into armatures, the actual time consumed, after allowance was set, being an average of 3 hours and 45 minutes. Taking this into consideration, on 7/17/08 we placed an allowance of 4 hours and 45 minutes on an almost identical operation. The time on day work before, the premium work after placing this allowance remained at 7 hours, the maximum being 8½ hours—the minimum 6 hours and 45 minutes. Frequent applications were made to have the allowance raised to 6 hours and 45 minutes. After a month of this, steps were taken to bring the allowance down to where it should be, with the result that the time consumed dropped from 7 hours to 3 hours and 15 minutes, lowering the time of the other job, it will be noted, by one-half hour.

In another case a man held out three months on a certain lathe operation consuming 25 per cent. more time than the allowance set. Upon being informed that the work would be taken away from him if he were not able to meet the allowance, he reduced it by approximately 50 per cent.

A great number of these instances could be cited, and from the above it will be seen that a weak-kneed or indifferent policy in setting premium allowances can only result in trouble and confusion.

In the above instances, the assistant in charge was passively sympathetic, and it required a private session with him in order to change conditions. But the fault was not entirely with the man, it lay in the setting of the first allowance.

My experience has been that most foremen are inclined to liberality rather than the reverse. This is probably due to the fact that it means less friction between themselves and their men, and is as it should be, as friction at that point destroys efficiency. The method used at the Wagner Company in setting allowances is to have the foreman send to the cost department an estimated minimum based upon the actual time required; this is compared with the records and, if no great discrepancy is found, 50 per cent. is added and it is sent to the superintendent for approval. Of course, we have our percentage of bad guesses, but that is not wholly a misfortune, as it causes the employee to be forever hopeful of drawing a prize, and when the allowance is where it should be, he hopes for better luck next time. But it is exceedingly important that mistakes shall not happen too often. The record cards are gone over periodically to compare the estimated minimum with the actual time.

I referred a moment ago to the foremen being liberal to avoid friction, and in that connection I think it much better in setting allowances to have it understood that they are set in the office, thus throwing the burden on the office and superintendent. It avails a man nothing to sulk and kick when the object of his anger is the office. Of course, the inference is that only justice is being done, but it should also be remembered that there is no relation between what a man says he can do and what he actually can do; he may be entirely honest in his convictions, but he himself does not know his capabilities. This leads up to another thought that is the complement of this, and incidentally to the crux of the premium system. If a man is unaware of his capabilities, we at the same time must dismiss any idea we may have that we can get the best of the man at the machine, legitimately. Within the bounds we set for him he always maintains the advantage, and while I have no hallucinations about the common interests of employer and employee, or that the average man will treat his employer honestly if he is so treated, I do know that, as in every walk of life, honesty pays; and so I wish to state with all the earnestness I can that the entire success of the premium or any other system lies in not changing the rate after once it has been set; if you have made a mistake in setting an allowance, grin and bear it until the time has expired for which it was guaranteed—if possible avoid changing it then.

Ill Effects of Lowering Allowances, Once Set

Great care should be exercised in the original setting of an allowance; it should be borne in mind that it is always possible to change an allowance that is set too low, but never policy to lower a high one. The only time that allowances should be changed is when the method of manufacture is radically changed through some specific improvement in jigs, fixtures, high-speed steel or new machinery.

Observation has shown me that where prices or allowances are cut, more is being paid on the average than is paid where the price is guaranteed for a definite time—as Lincoln said, you cannot fool all the people all the time, and where prices are cut the men figure it out that they receive no more for hard labor than for taking their leisure, and act accordingly; so instead of gaining on your premium or piece work plan, you are simply giving an unearned bonus for no value received.

Calculating Premiums Earned

The next step in the system, after the work is done, is that the operator writes on his time card the name of the piece, drawing number, time commenced, and time and number finished. This latter number must coincide with the number of usable parts as shown on the back of his work order, and O. K.'d by the inspector. These are checked each morning by the clerk before the time slips are sent to the office. When a job is started, the man puts an X in its proper square on his time card; if the job takes him three days, for instance, he marks the number finished on his slip on the third day; his other slips in the meantime have been placed in the unfinished file, and upon receipt of his final time card they are taken out and the premium calculated. The holding up of these slips does not interfere with the recording of his hourly time.

Inspection Department Essential

Next in importance to the records is the inspection of finished parts. Under the day-work system all spoiled work is the result of carelessness or incompetency and is accepted as a necessary evil. The opinion seems to prevail that more allowance must be made for bad work on piece or premium than on day work. This is true if there is not an efficient inspection system. Where there is one, and a man paid only for usable parts, quite the opposite is true. This bad work is what the inspection department takes care of, and the operator is paid for only that work to which the inspector has certified. I wish here to emphasize, that to make the system efficient, only usable pieces should be paid for. At the Wagner Company's plant each man is provided with a steel stamp with two of his initials on it. Each piece over a predetermined size or weight is marked with this stamp; below that, one piece is stamped. They are all inspected before going to the next operator, and the number of usable parts is written before the next operation; thus, if a man starts with 105 pieces and spoils 10, the next man receives a card for 95, and thus has no excuse for claiming 105 pieces, nor does he waste his time on those that are defective from any cause. The inspector also places on any faulty parts a red tag which may be removed only by himself, stating the drawing number, quantity, and fault, and the stub of this is sent to the superintendent's office each day for disposition. After this is done, those parts which are to be returned to the manufacturer, or scrapped because of bad work, are listed and sent to the cost department each day. This list enables the production department to order castings or parts to replace those defective from any cause, and the cost department to make proper correction in the compensation of the man who did the work.

Charging Back Defective Work

Our policy in regard to computing premiums for usable parts only, was taken after extensive inquiry among other firms, and much thought and discussion on our part. It is epitomized in the following interpretation from our general manager:

"April 10, 1908.

INTERPRETATION—PREMIUM ALLOWANCE AND CHARGES

"The following rules for determining the amount of premium earned, will become operative May 1, 1908:

Credits

1. No change will be made in determining premiums earned where workmanship is satisfactory and materials are not defective. The workman will be credited with the number of hours actually required by the job, plus one-half the hours saved between the actual hours and the allowance.

2. When materials prove defective after some work has been done, the workman will immediately notify the foreman, and the foreman will O. K. time slip at the hourly rate for the amount of time put in on the defective material.

Charges

1. For all pieces finally rejected by the inspector and scrapped, charges will be made per piece at the time allowance rate.

2. For work which is corrected before turning in time, the hours employed correcting same shall be considered as time put in upon the job.

General

Charges and credits will be carried from pay-roll to pay-roll. As far as possible all these items will be adjusted every pay day, but if defective work is corrected after any given pay day, the adjustment will be made at the next pay day.

In no instance will back charges for defective work be permitted to reduce wages below what the workman should earn at his hourly rate. Any workman repeatedly spoiling work will be regarded as an unsatisfactory employee and will be discharged.

When work is rejected by the inspector, the workman will be notified in each instance and told the reason for the rejection. He will also be notified of the amount charged back against him for defective work.

When work is corrected by the workman after his time slip has been made up and turned in, no allowance will be made for such time and no record of it kept."

To those not familiar with the premium system, this may seem a little involved, but the one point that stands out clearly is that under no consideration is a man's pay to be less than his daily rate. In practice this rule works as follows:

If a man does 50 pieces with a time allowance of 10 minutes each, and spoils 10 of them, 100 minutes are deducted—not from this specific job, but from his total premium earned during the pay period. The advisability and possible injustice of this were the chief obstacles in applying the rule. After considerable study, it was decided that inasmuch as the premium earned is a bonus for good and rapid work, the employee was entitled to it only when honestly earned. If it were deducted only from the specific job upon which work is spoiled, the dishonest man would so manipulate his time that no premium would be made. As an example—If the total time allowed on a certain number of pieces were 5 hours, and enough were spoiled to eat up any premium that might be earned, the man could turn in 5 hours or more on his time card, although the actual time taken was but three hours, thus there would be no premium to deduct from; then the man would shorten up his next job by the amount he lengthened the previous one, thereby increasing his premium to that extent, and defeating the working of the rule.

Here the psychological aspect of the case came into play and by some the opinion was freely expressed that the men would consider this an injustice. In practice, this has not been so; small clerical errors have occasioned friction, but only one complaint has been seriously made. This was the case of a man who spoiled some work by turning it too small. This was charged back against him, and he appealed from the charge to myself; I sustained the foreman, and the man then appealed to the general manager. The record showed that the amount involved was $2.72; the loss to the company for material was $30; also that the man had made during the week $7.68 premium in addition to the $2.72 involved. His excuse for spoiling the work was that he misread his micrometer. The general manager sustained the foreman and inspection department, and nothing more was ever

heard about the matter; it is possible that this was put forward as a test case, as no other complaint has ever been received.

Accuracy of Time Cards

The third most important feature is accuracy of time-card records in the shop. This is necessary both for cost department records and for the protection of the employer. Most of us consider it no crime to cheat the gas company or the railroad, and so with the average man it is no crime to match wits with the company. If you find him out, he tells you the other men do it and that you should have some system to take care of it. The cheating has many variations, but the most common are charging excessive time to a day-work job and shortening the premium time Another nearly similar, is to charge excessive time to a small premium job and shorten it on a large one. Still another variation is to turn in a small part of the job, say 10 out of 100 castings, at excessive time and shorten the time on the remainder.

Classification of Men

The last point upon which I wish to touch is the classification of men. In many shops this is a source of considerable trouble. I think the following note will cover the question fully, and is the practice with the Wagner Company:

"Dear Sir:—Answering your inquiry, I agree fully in the proposition that a very exceptional and speedy man should not be the criterion for establishing a premium rate. Such a man should be permitted to earn a larger premium than we would consider good practice with what you might term the 'normal speedy man.' I would classify the shop men on the following basis:

1. The exceptionally speedy man.
2. The high-grade speedy man.
3. Above the average.
4. The man who makes time allowance only.
5. The slow man.

I would fix premiums for No. 2 to make what we consider a reasonable premium. As to No. 1 above, I would not concern myself particularly one way or the other.

W. A. Layman,
Vice-Pres. & Gen. Mgr."

Thus with five classes of men, we concern ourselves only with one, and if we consistently follow up our records, keeping our foremen advised as to the men who are falling behind, we can investigate and find out whether the allowance is at fault or the man, and take steps accordingly.

General Conclusions

It may seem to some of my hearers that I am condemning the premium system rather than recommending it, but such is not the case. I am very optimistic in regard to it, but the trouble has been that most published articles, when not distinctly condemnatory, have been entirely too optimistic, and have had a tendency to influence one to install the system without sufficient preparation or knowledge of its difficulties. Here, as elsewhere, something cannot be obtained for nothing, and if you are not optimistic enough to read between the lines of this article, and conclude that the premium system is what you want, my advice would be, don't try it. If you are a good healthy optimist, and believe that conditions in your factory are not as bad as they are elsewhere, try it and you will be pleased with results.

However, changing from day work to premium work as a cure for laziness, or to prevent soldiering, is simply dodging the issue, because the man who killed time will simply change over and kill quality in his work. There ought to be better methods of stimulating effort; when the other methods fail it is time to get better men.

In conclusion, I beg to state that I hold no brief for the premium system, but have simply sought to present such facts as have come to my notice, and to note weaknesses that are inherent in it and all similar systems, and which only care and patience can take care of, each one working out that variation which best fits his particular case.

"Only Men Now Employed Need Apply"

By Geo. P. Pearce

Are we entering upon an era of frenzied business methods or has the late panic left the heads of some of the manufacturing concerns in a maelstrom of hoggish fear? Recently I have noticed the above deliberately inserted in some "Help Wanted" advertisements.

Why not tell the whole story and say: "We are not necessarily looking for the best man that can be got but we wish to get the best man we can from our business rivals and thus not only advance our organization, but at the same time cripple those who compete with us in the open market."

Because a man is temporarily out of employment it is no proof that he is inefficient or a "haswasser." The best of superintendents or the most efficient foreman may be connected with a business enterprise and through some unfortunate financial deal, change in the market demands, absorption by a trust or any other such cause which may occur, be apt to find himself thrown out of employment. Surely no one, even with the most distorted views or "get rich at any cost" methods, could claim that these men were not worth their hire simply because they were out of employment.

Edison does not seem to be making a failure of life by any means; one would not claim that the late Marshall Field was not successful; yet we are told that these as well as other eminently successful men were "fired" at least once in their lives because their employers thought they were "inefficient."

Fate, indeed, is the greatest of all jokes; the dismal failure of one employer is the keystone of his competitor's success. Let these theoretical fantastic notions be solemnly buried and we will then return to the good old civilization method which is now giving, and for past centuries has given, every man a hearing before passing judgment upon his worth.

Podonk Smythers—the Man Who Knew It All

By A. S. Atkinson

When a man knows it all there isn't much use to argue or to try to demonstrate with him, for he either won't or can't see the point of your argument, and talking to such a person is very much like pouring water into a barrel with the bottom knocked out. When a man gets to the point where he thinks the last improvement is made in his shop, and the last word has been said in machinery, inventions and other developments of a mechanical nature, he has ceased to be a desirable factor to his employer, and it is about time a change was made in the whole shop management.

That was the cause of the undoing of Podonk Smythers, who became manager of the A. X. Z. plant through one of those peculiar changes which occasionally stir up the bottom of things and land some of the sediment on top, where it manages to stick for a time. Podonk had been a bookkeeper, then shipping clerk and office manager, and what he didn't know about machinery, engines, and all the equipment of a big shop you couldn't find on shipping bills, cost cards and in catalogs. Smythers knew it all, theoretically, at least, and he knew the cost as well as something about their use. He had dealt with the buying department and had done some buying himself—from catalogs—and of course he could talk machinery with the best of them. Who couldn't with his training and education?

But Podonk was a misfit in the shop, and a miracle as a manager. It was because the previous manager had paid more attention to instructing the men how to get out good work and studying how old machines could be made to do double work than to keeping cost accounts of piece work that Podonk got his boost. The president wanted someone in the machine shop who could keep him posted on the price of nails and wire and the amount of time needed for making a piston rod or boring a cylinder.

Smythers was O. K. in this matter, and

for a time things went lovely—from the president's point of view. The reports he made out were beautiful, and the hand writing made you hate to smudge it with your oily hands. Nobody regretted this more than Smythers, who was as neat and clean as a polished brass rod.

But somehow no one in the shop got along with him. Billy, who always did the filing, couldn't keep an accurate account of the filings he collected on his bench, and Podonk made life miserable for him in trying to save this waste. Old Belknap, who ran the turret lathe, didn't know how much power he was using to turn a rough bar into finished work, and he didn't care a ——— either. Then little Tom, who was a genius in his line, complained that the light was bad in his corner of the shop, and said he could increase the accuracy of his work if he could see better. Tommy asked for a new electric lamp, and got a lecture.

Podonk Knew All about the Forging Hammer

But the worst of it came out with Surry, the man responsible for the big forge hammer. Surry was as surly as his name suggested, and he had a fist like the big trip hammer he operated. When he wanted a thing, he wanted it bad, and didn't hesitate to ask for it. If he couldn't get it he kicked, and sometimes he swore. Surry had some fine work to do, and the old hammer was forever spoiling his best work. It was an ancient institution, and inclined to balk and go wrong at the critical moment. When he wanted to deliver a gentle tap, the cranky hammer was more than likely to give a thump that shook the whole building.

He kicked and kicked, and finally demanded a new hammer. Podonk came along and asked why. "Why?" blurted out Surry wrathfully, "why, because this damned old thing is a disgrace to the shop." Podonk smiled, and said; "That hammer is the best made, and it is—" "Hold on," interrupted Surry, "it *was* the best made. But it ain't so no more."

But Podonk said it was all right, and a new one was not needed. So Surry went back to his old hammer and continued to ruin some fine material. The exasperation to his feelings was nothing to the new manager. He knew it all and wasn't going to throw a big steam hammer away just because it was old and was past its days of usefulness. He knew what he was talking about, too, for he had bought this hammer.

Then one day Surry hammered into a shapeless mass about a thousand dollars' worth of sheet steel, and calmly laid the whole trouble at the door of the aforesaid hammer. But Podonk knew better. He had ruined the metal out of spite, and Surry got his quit papers. The discharged man went to the president, who out of consideration for his past services gave him a position as watchman, and Surry being old didn't kick. He knew that some day he'd have to quit the hard work and take the easy jobs at less pay anyway.

Podonk Knew All about the Gas-engine Plant

Then young Bennett, who was engaged to look after the new gas-producer plant, because he knew all about such things, asked for permission to make a change in the jacket-water supply. He said the pressure on the city pipes was so uncertain that he was afraid the cylinders would be burnt out some day when the pressure was off. He said he could rig up a storage reservoir and feed the water by gravity under constant pressure. But Podonk didn't see it that way. That gas producer was the best in the market—for he had looked it up—and the company making it had installed it according to directions.

What did a young gas engineer know about such matters? Bennett had been retained by the company to run the gas producer and not to change, alter, rebuild or improve it. Practice is all right, but theory is better—sometimes.

Bennett didn't get the opportunity to fix up his water reservoir, and things went along smoothly, which justified Podonk in his decision. But some day things always go wrong in a shop. The new man running Surry's big hammer got cranky one morning and smashed another piece of half-finished work and made it necessary to reforge it.

Then came young Bennett into Podonk's presence, and stated excitedly: "Something's gone wrong with the gas engine, and she's out of commission." Podonk frowned and demanded the nature of the trouble. "It's the water, I think," was the reply. "They shut off the branch main this morning to make some street repairs, and they failed to notify us. And, I guess, the cylinders are burnt out."

Podonk was no machinist or engineer, but he had heard of such things as cylinder heads blowing out and cylinders getting too hot for their health when the jacket water failed to circulate properly. He knew enough anyway to know that there was trouble ahead for somebody.

Bennett wasn't a bit troubled when he took off the cylinder head and exposed the seat of the trouble. Podonk was serious for once in his life, and a little bit worried. He tried to trip Bennett into admitting that the fault was his. But the fault could be laid only to the city, and the water department hadn't made any guarantee that it would keep up a uniform supply of water. Podonk had taken the water without any agreement other than that the company would pay for all the water it used through the meter.

It cost a good deal to get a new engine and even more through the delay in holding up all the machines dependent upon the gas plant for their power. There was a good deal of fuming and threatening, and things looked blustery for several days. Podonk had some heart-to-heart talks with the president, who wasn't so sure that he had the right man in the right place.

Podonk Knew All about an Invention

But the final coup came when Smithers made his invention and sold it to a rival shop. This came about in the same way that the other mishaps turned up. Smithers was a genius in his way, and he had that happy knack of studying a machine and making improvements that always helped along. He had imagination, Smithers had, and we boys always deferred to his judgment when he spoke. There was Jimmy's belt which gave trouble in slipping until Smithers fixed up a wooden guide that held it firm. Wilson's planer had been unevenly set on its foundations and sometimes it wabbled so that mistakes were made until Smithers jacked it up and made it as firm as the Rock of Gibraltar. Every shop has a Smithers in it, or ought to have. He sees where others merely guess or wonder. Why, Smithers had marked the whole shop with his handiwork and had saved the old man hundreds of dollars by his little devices.

Of course, Podonk didn't know of this or at least he wouldn't admit it. He had some of these homemade devices cut out and others substituted. It looked patchy to him. But Smithers went on inventing, patching and jacking up, for he enjoyed the work. He was in his element when he was improving things.

One day he approached Podonk at the noon hour, and announced with eyes stretched wide open, "I have it, Mr. Smythers." Podonk wasn't very genial in those days, and he asked in his coldest manner what he had. "Why, sir, a great improvement—an invention that will save us thousands of dollars."

Then he went off into a detailed description of his wonderful device for cutting and bending bars so that about half the hand labor would be saved. Podonk didn't grasp the idea, and said he wasn't interested. Old Smithers was disappointed and said he'd demonstrate it later. So he built a model of his invention and tried to get the manager interested in that way. But Podonk frowned, and said; "If it would do all that, the machinery manufacturers would have jumped at it years ago." Smithers scratched his head and said nothing. What was the use? He tried again and again to take up the matter with the manager, but it was no use.

"Boys, I leave this shop," the old man said a few weeks later. "I've got a good thing here, but that—that idiot wouldn't listen to anything. He knows it all."

Smithers did leave; we found out later that he had patented his invention, and a rival shop had offered him a good salary

and royalties on the invention if he would come over to them. And he went! Within a year he had cheapened the cost of manufacturing our specialties until it looked as if we were heading straight for bankruptcy. The whole story came out later when the president found that Smithers was no longer in the shop. "Why did we let him go?—and with that invention?"

The President Knew about Podonk

We didn't hear Podonk's explanations, but there was a change in the shop shortly after that. Podonk didn't know it all after all, or at least the president didn't think he did. We got a shop manager then who knew something, but not all, and he was willing to learn something new from the men. Smithers came back finally, and he's been with us ever since. When he gets a new idea now he gets a respectful hearing, and more than likely he gets something more.

The Worcester Trade School

By Entropy

Nearly a year ago I outlined what is known as the Worcester plan of trade school. The intervening time has been taken up with the necessary steps of getting an appropriation from the city government and finding an acceptable lot of land and planning a building. At present writing the trustees have $125,000 at their command, a lot of land under option, approximately, 200x280 feet of level ground, facing on a public square on which are the State Armory, Society of Antiquity building and a church. Nearby is the old art museum and also in view the site for the new one about to be built. The rear of the lot is in a manufacturing region with side-track facilities. Contrary to usual custom this lot was offered at about one-half its market value by the trustees of the art museum. About one-quarter of this lot will be used at once for a boy's school for the machinists' and allied trades. The plans accepted show a brick building, the front on Armory Square about 50x60 feet, with basement and three floors. The rear, 40x210 feet with basement and two other floors. The front or head house above the basement is devoted to recitation rooms and administration, the rest to shops, the basement (which is mostly above ground) and first floor for machine work and the top floor for wood work. The building is calculated to accommodate 250 to 300 day, and nearly as many evening pupils.

The plans submitted for the use of the rest of the lot are only tentative, but they show accommodations for in the vicinity of 1000 or 1200 pupils in foundry, carpentry, masonry, sheet-metal work, etc., the intention obviously being to enlarge the school as rapidly as possible so that all of the trades most practiced in the city may be accommodated. Under the State law the city will be reimbursed to the extent of one-half of the cost of maintenance each year, which will probably bring the net cost to the city to a point comparable with the cost of running the academic high schools.

This is quite different from paying students wages and trying to make the school pay its own way. It seems to be the opinion of many that if it is reasonable that prospective college students, embryo professional men, should be educated at the city's expense, then it is also reasonable that as much money per pupil should be made available for the prospective machinist. On the other hand, if it is possible to reduce that amount by the sale of product it can be done provided a way is found that will not conflict with manufacturing interests.

Under the State law no child can be admitted under 14 years of age, that being the age limit at which compulsary schooling stops. Since it was the feeling of the local commission that boys under 18 years of age were not likely to be in large demand as journeymen no matter what their training, a four-year course was decided upon, which latter, of course, may be modified later though public opinion seems to be strongly in favor of occupying the time of boys between 14 and 16 years of age in some way, thus preventing the raising of the age of admission, and public opinion among working people, at least, forbids unduly shortening the time due to a desire that the boys shall have really and thoroughly learned their trade before being sent out to earn their living.

The plan of the present board of trustees, a majority of whom were on the old commission, seems to be practically the same as a year ago. Briefly it is that boys shall be offered a course of four years, eleven months per year, of which time about 22 hours per week are to be spent in the shops in actual work, all lectures and instructions in general being given outside that time and in addition they will spend about 12 hours per week in drawing and recitations, the recitations being in lines chosen for their value to the pupil in later life both as a citizen and a mechanic. Enough academic work will be given so that no boy who develops ability need look back on his course with regret that he missed the chance of sufficient education to carry him high nor will the school be in any sense a training school for a higher institution of learning. That is, the school will stand as an independent unit drawing on the city schools for boys of eligible years, even though they may be far behind in their studies. These boys will be given a chance to see whether they can develop into workmen. Ultimately all the more common trades will be offered for their choice, but at present only those showing some aptitude or liking for the machine trade can be accommodated. Their education from the time that they enter until they graduate will be distinctly different from that offered by the public schools. Take history for example; instead of a rehearsal or review of the nation's battles, quarrels and conquests, they will study the history of the country's commercial progress, the history of invention and the peaceful progress that has made the financing of her wars possible.

Thus, in every way the better nature of the boys will be aroused, their interest in their work stimulated by showing them its application to every-day life, the feeling being that the present system of schools, colleges and technical schools furnish abundant opportunity for that body of boys whose student proclivities are such as to lead them to work to follow their ideals, but that the new school must properly recruit its ranks largely from those to whom some of the higher motives of life do not yet appeal.

During the formative period of this, the Worcester, plan the Schneider and Fitchburg plans were suggested to the Commission. The reasons why they were not adopted appear to be as follows:

The Fitchburg plan appears to depend for its success on a selection of boys. That is, given a sufficiently large number of applicants a sufficient number to fill the Fitchburg shops could easily be picked whose natural ability would easily carry them through the shops to good positions without special effort on the part of the foremen under whom they were placed. Manufacturers naturally preferring that kind of a boy will and, I am told, do turn out less capable boys and call for new recruits until they get what they want.

In Worcester the feeling was that a school was needed for the masses, not for a few specially bright boys among those masses, but a school where ultimately every boy to whom $3 a day looks like big money can go and find a trade taught that will appeal to his tastes and capabilities, provided he has any of either. If this view is taken it is obvious that an equal opportunity must be offered to all candidates who do not show strong symptoms of inability to learn the trade which they wish. The Worcester school very likely cannot meet the demand for some time to come, but after a time it should be able to give all applicants an equally fair showing.

Then again it has been suggested that the object of all this agitation is to teach a trade more thoroughly than is possible in our shops today, that is, the primary idea of the trade-school crank is not to upset present-day school methods, but to teach a trade better than it has been taught before. Under the Fitchburg plan

the shop conditions are no different, the attitude of the foreman toward the apprentice is in nowise changed from what it was 10 or 20 years ago, and there is nothing to make the foreman better adapted or better disposed to teach the boy than before. The only thing changed is the boy. The Fitchburg plan offers a larger number of boys for the shops to choose from.

Neither the shops nor their equipment are changed by the Fitchburg plan, while by the Worcester plan a shop will be built up whose equipment will represent the modern methods of manufacture. Unfortunately Worcester has many shops that, under the Fitchburg plan, would be entitled to have boys from the school, but whose equipment and methods are anything but what a boy ought to have if he is to be turned out a modern mechanic.

More than that there are few shops except the large ones that have the variety of work to offer an apprentice to make a really all-round machinist of him. The coöperation of the local shops is expected in that they will undoubtedly furnish a large range of work which the school will do, buying the material from the manufacturers and selling all of the finished product back to them at a price established by the cost as manufactured in their own shops.

Our Patent Laws

By E. J. Stoddard

There seems to be such a feeling of unrest due to the knowledge that our patent law, or rather the administration of it, is defective, that something will be done to improve matters. What shall this something be?

It is not well that present conditions should continue, or grow worse, which must be the inevitable result of taking no action, because the evils arise largely from inadequacy of means for dealing with conditions of continually increasing complexity. General distrust of our laws means a failure of the incentive they were designed to afford, and the fading of the light of American inventive genius.

Judge Brawley says in Crown Cork and Seal Company vs. Aluminum Stopper Company, 96 O. G. 2585: "The protection and hope of profit held out by our patent laws inspire that stimulating energy which leads to experiments, invention and all the resulting benefits. A refusal of that protection in a proper case will deaden and destroy it."

On the other hand a radical and sweeping change means doing away with a system that is fundamentally good, and has in some respects served as a model for the whole civilized world, and substituting for it anarchy and confusion. We should not hastily adopt the suggestions of the rabid iconoclast, nor the melodramatic utterances of the orator, intended to move inert material and not to guide sober counsels. The whole matter should be placed in the hands of a properly constituted Court of Patent Appeals, which should be constituted not only to hear appeals in patent cases but also to inaugurate and conserve a proper administrative system.

Such a court should consist in the main of lawyers to secure steadiness and consistency, and it should consist in part of experts to secure initiative and a knowledge of the facts and their relation to each other, with which the patent law has to deal. Surely the greatest wisdom is in vain if it has not the data upon which to form a judgment. "The mere handling of tools will not make a man a skilled workman, or master of defense, nor be of any use to him who knows not the nature of each, and has never bestowed any attention upon them."—Plato's Republic Book II, Jowett.

In 1877, the Supreme Court said: "It would perhaps be desirable if all cases of this sort could be referred to a commission of intelligent experts and practical men to report their opinion thereon, with their reasons, for the final action of the court. A proceeding of this kind was probably in the mind of Congress in passing the Act of February 16, 1875, authorizing a reference to a jury of five persons. Neither courts nor ordinary juries are perfectly adapted to the investigation of mechanical and scientific questions."—Cochrane vs. Deener II Brodix 333.

The following is a quotation from a decision of the Supreme Court dated June 1, 1908: "The defense of want of invention in the Liddell machine is not urged here, because it is said that the decision of that question depends upon mechanical comparisons too numerous and complicated to be conveniently made by a bench of Judges."—Continental Paper Company vs. Eastern Paper Bag Company.—136 O. G. 1297.

Obviously there should be two experts attached to the court; one to sit with the judges hearing a case and the other to assist in the preparation of opinions.

These experts should bear weight in shaping the policy of the court and in establishing the practice in patent cases for the inferior courts. It is hard for a lawyer to change a time-honored practice even after it has been shown to be erroneous. Science has been the dominating influence for the last century and it has produced its effect upon our civilization and mode of thinking. See e. g. "What is History," Karl Lemprecht, and Benthams' "Fragment of Government." Scientific education is not merely the accumulation of facts, it is a mental training, a character-forming influence. The spirit and mode of thinking, which is the chief modern formative influence, should be introduced into our jurisprudence, especially that branch of it which relates to the applied sciences.

In this way we may well hope to have a tribunal "in whose hands the Patent Law may grow and develop, as the necessities of the future may demand, into a great, consistent, harmonious, wise and satisfactory body of rules which will be of equal value to the inventor and the public." Editorial—American Machinist, March 11, 1909.

The bill recently presented to Congress contains the best plan that can be hoped for from the lawyers only. It is, however, only adapted to secure partial relief. A court composed only of lawyers is obviously inadequate to try and determine cases of mixed law and science. The new court, as suggested by the bill, will be better than the former courts because its members will know or learn a little more about mechanics and the applied sciences, but this knowledge will be necessarily superficial and incomplete. Professor John Perry says, "In England our lawyers and judges almost without exception are quite ignorant of the most elementary facts of Physical Science. In a patent case, the court has to be educated at a terrible expense, and at the end of 10 or 20 days one sees that the judge is nearly as ignorant as at the beginning."

The theory of the patent law is simple, its application is of all degrees of complexity, the application of the patent law is the work of the engineer, working with the tools and after the methods of the lawyer. A real knowledge of the history of an art is necessary in order to consistently guide its development.

I think the importance of this matter is not fully realized or there would be an organized effort to remedy existing defects. Many look to the American Machinist for suggestions in this line. You would have a greater public recognition of inventors! Very good! Our prestige among the nations in a measure depends upon this. Why, then, do we not put men who have knowledge of, and sympathy with, such matters in a place of influence—men that we could honor and hold responsible?

Carefully prepared statistics show that the mined production of crystalline graphite in the United States in 1908 was 3,433,033 pounds, valued at $149,763, while the same authority states that the output of electric furnace graphite in 1908 was 7,385,511 pounds, valued at $502,667. These figures are most interesting in that they define how man, aided by science, has developed a process that gives to the world more graphite every year than is mined in the United States.

Practical Letters from Our Readers

A Round Table Discussing Details of Modern Machine-shop and Drawing-office Methods, Practice and Economy

WE PAY FOR USEFUL IDEAS

Manufacture of Eccentric Piston Rings

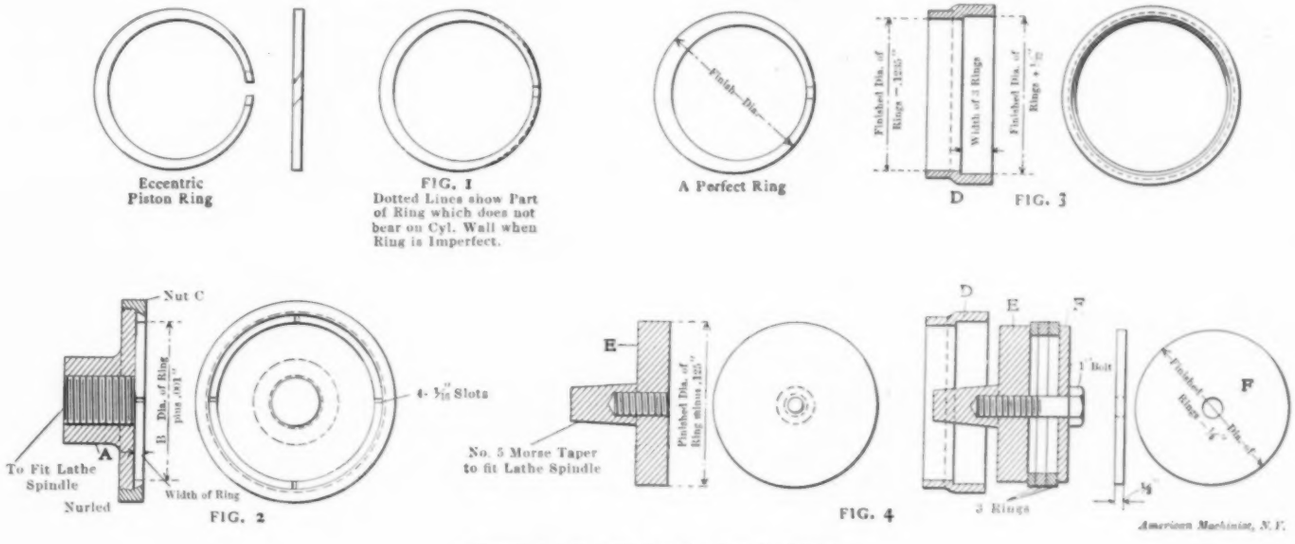
A piston ring is a very important part of a gasolene or gas engine. We all know what a defective ring means, a loss of compression which naturally means loss of power. For a number of years it was the practice of many prominent manufacturers to put their rings through some fifteen operations, but with the fixtures shown below, grinding and quite a few other operations are eliminated and the cost of the rings reduced 50 per cent., which is more than the cost of the simple fixtures. In referring to the fixtures shown in the sketches it can be seen that they are not as elaborate as one might judge they ought to be to produce an accurate ring. The secret of a perfect eccentric ring is to eliminate the hump which presents itself at the slot when the ring is slotted and ready to put in the cylinder, as the ring in this shape will only bear on the two high spots as shown in Fig. 1, by the dotted lines.

If the rings are placed on the piston and the piston placed in the cylinder, then by adding a little oil to the cylinder wall and working the piston up and down, also slightly revolving it, it can be easily learned if the ring has a bearing at all points. If the ring shows wear on two points only it is evident that it is not perfect and should it be used in this shape it would mean a loss of compression and consequently a loss of power, as previously stated. Since we have been making our rings with the fixtures described in this article our engines have been giving us from 1½ to 7 horsepower more on the test block, which shows the value of perfect rings.

The first operation on the ring is to turn the outside diameter of the ring eccentric, allowing 1/32 inch on the diameter for finishing. At the same time the inside diameter is finished, after which the rings are cut off 1/64 inch over the required width, this amount being allowed for truing up the ring after it is slotted. After the rings are cut off they are clamped in a 6-inch face plate. This plate is recessed to center the ring. They are then slotted in a hand miller, a spacing collar being used to space the saws. In slotting the rings 1/64 should be allowed for filing the slots to the required opening. After this operation is complete the rings are placed in the fixture shown in Fig. 2 and cut to the required width. With this fixture our rings vary but 0.0005 in width.

The hub of the fixture *A* is threaded to fit the lathe spindle, the diameter *B* should be 0.001 larger than the outside diameter of the ring and four 1/16-inch slots should be cut into it to give the necessary tension to grip the rings when the nut *C* is threaded on. The nut and fixture are tapered in order to get the action of a spring chuck. The nut is also nurled to permit the fixture to be used without the aid of any wrenches, making this operation quick and simple. The ring is placed in the fixture, the nut tightened and a very light cut taken off the ring, just enough to true it up. The ring is then reversed in the fixture and faced off flush with the side of the fixture. This should be done with a sharp-pointed tool and at high speed to get the best results. The rings are then put in the fixture *D*, Fig. 3, which can be made to hold from one to five rings, but I have found it best to make the fixture to hold three rings. This fixture is then slid on the fixture *E*, Fig. 4, which is fitted to the lathe spindle, the rings being centered from the outside diameter of the fixture. The plate *F*, Fig. 4, is then placed against the rings as shown and the fixtures and rings held with a 1-inch bolt. Fixture *D* is then slid back and the rings finished to proper outside diameter.

St. Louis, Mo. C. T. SCHAEFER.



FIXTURES FOR ECCENTRIC PISTON RINGS

Slotting a Blank Holder in the Punch Press

We received a set of large oval-shaped dies to be tried out in our No. 3½ Bliss toggle press but found the punch almost ¾ inch too long to pass through the blank-holder slide.

Instead of disassembling and machining we turned a shank on a piece of 1¼ inch square machine steel, to fit our shaper extension tool holder, (as it will later be useful for cutting out square blanking dies and draw-rings), drilled and tapped it for the tool clamp *A*. We then turned

an eccentric bushing to fit our punch-holding block (found in all die shops for grinding and clamping to faceplate for facing and boring punch holders).

The tool, placed in the bushing, was then set in the punch block and clamped to the circular-milling attachment of the B. & S. miller, and altogether it was clamped to the bolster of the press. The blank-holder slide was then set to pass the tool, the press started and by turning the circular attachment the opening was enlarged in a very short time as everything is good and stiff and allows a heavy cut to be taken.

R. E. ROBERTS.

Cleveland, O.

An Arc Turning Tool

In making up a gate of metal patterns we were recently required to furnish the pattern shop with a number of brass pulleys as shown in section in Fig. 1. These pulleys had to be alike, and of most importance were the dimensions of the groove and the distance from the bottom of the groove to the center of the hole for the axle. In order to meet those conditions, I designed the tool shown in Fig. 2. *A* is the holder which goes in the tool post on the lathe and holds the cutter tool *B*. The cutter *B* is held to the tool holder by, and rotates on the screw *C*.

The cutter is made of tool steel and is provided with two cutting points, one for roughing and the other for finishing. It has two holes for the spanner wrench shown in Fig. 3. The operation is as follows:

The center of the cutter *B* is brought to the proper distance from the center of the arbor carrying the pulley. The spanner wrench is then put in the holes, the cutter is rotated and the roughing cut is taken. Then the finishing cut is taken which completes the operation.

The pulleys came right to size and very smooth and this operation was performed very quickly. The tool more than paid for itself on this job but we expect to use the holder on similar jobs by making new finishing tools.

Rochester, N. Y. A. N. H.

Jig Boring Tool

Some time ago I noticed a sketch of a jig-boring tool which was, to say the least, a very nicely gotten up affair having a dovetailed slide upon which the part which received the tool point was moved off the center to adjust the cut. The accompanying sketch shows tool made for the same purpose but much more simple in construction and quite as efficient.

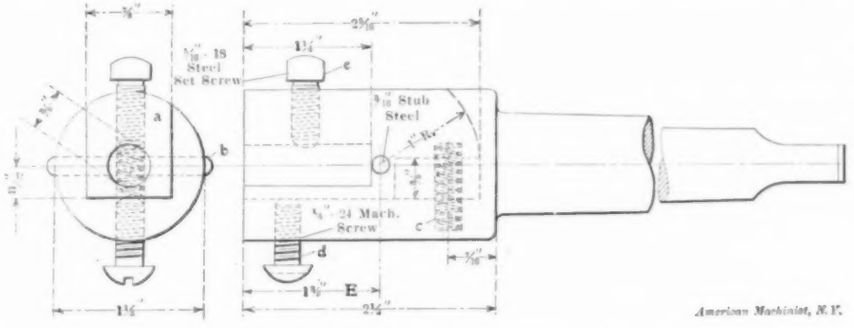
The body is made of soft machinery steel with a slot milled out, as shown, to receive block *a*, which is held in place by the pivot pin *b* and spring *c*; this block, it will be seen, is adjusted by the screw *d* which, when moved to the right a trifle causes the tool point to move an amount proportionate to the length of the tool to distance *E*, throwing the axis of the tool at an angle with the axis of the holder. Care should be taken always to set the tool so the pressure of the cut comes against the adjusting screw and not against the spring; were it set against the spring it would be nearly impossible to get a good, true hole. Set screw *e* is merely to clamp the tool.

Scranton, Penn. L. E. SALMON.

A Spanner Wrench for Shafts

The accompanying cut shows a tool that has proved so useful I want others to have the benefit.

The shape shown is the result of something like two years' evolution. It is christened the "Twister" and is used for revolving (by hand) armatures and revolving fields of electrical machines during the process of erection and inspection and of course works equally well on other similar things. The need of something of the kind was strongly felt by the inspector who found the keyways on the shafts frequently damaged by the use of monkey wrenches and the use of pipe wrenches, by erectors.



ADJUSTABLE TOOL HOLDER FOR THE MILLING MACHINE

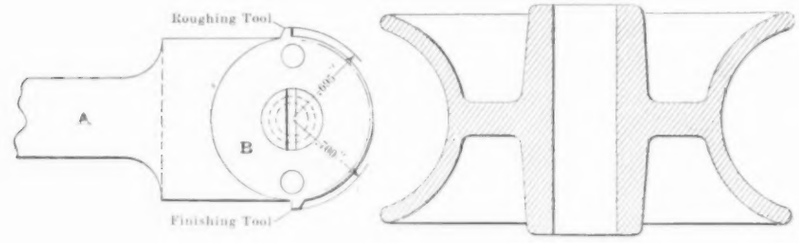


FIG. 1

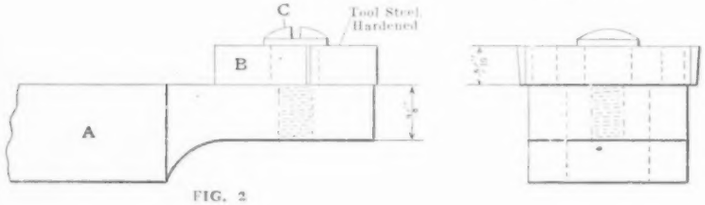
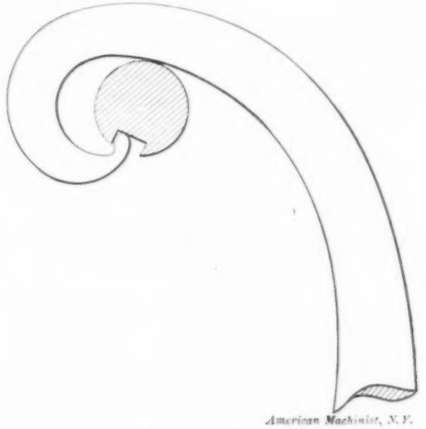


FIG. 2

FIG. 3

ARC TURNING TOOL



A SPANNER WRENCH FOR SHAFTS

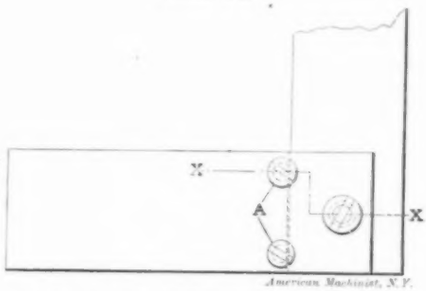
The shape given can be used in revolving shafts from 1 to 6 inches diameter without damaging the keyway. It is made of ½x1-inch steel.

IRA CRAMP.

Chicago, Ill.

An Adjustable Square

The illustration shows a try-square that I know is a good one. It doesn't require any explanation except to say the taper screws *A* are 10 degrees included angle; this I found to do nicely. Of course, by



A SQUARE WITH AN ADJUSTABLE BLADE

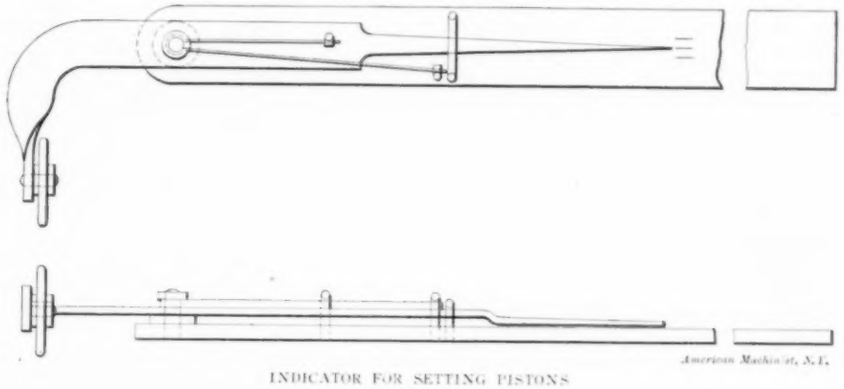
moving one or the other, the position of the blade with respect to the base of the square is altered. Hence the square is easily trued up.

O. G. SIMMONS.

Washington, D. C.

Indicator for Piston Work

The pistons were bored out to fit an adapter for the operation of turning and cutting the grooves. It was rather difficult to set them from the core as one could not see past the bosses and an indicator was made to get over this difficulty. The indicator, as the sketch shows, is quite a simple affair and cheaply made. It consists of a holder made of 5/8x1/8-inch



INDICATOR FOR SETTING PISTONS

mild-steel bar 10 inches long, which is held in the tool post. The holder carries on its end an indicator which multiplies the error about 4 to 1. The indicator has a 3/4-inch cast-steel roller which comes in contact with the interior of the piston. The spring is a piece of 1/16x1/32-inch spring steel bent to the shape shown and held by two pieces of 1/16-inch wire tapped into the holder and indicator and then bent over. A bridge is made of 1/16 inch wire to confine the indicator. The holder is graduated in limits allowable in setting the pistons. The indicator is bent in the manner shown so as to miss the bosses inside the piston. It has been in use for some time now and is very satisfactory.

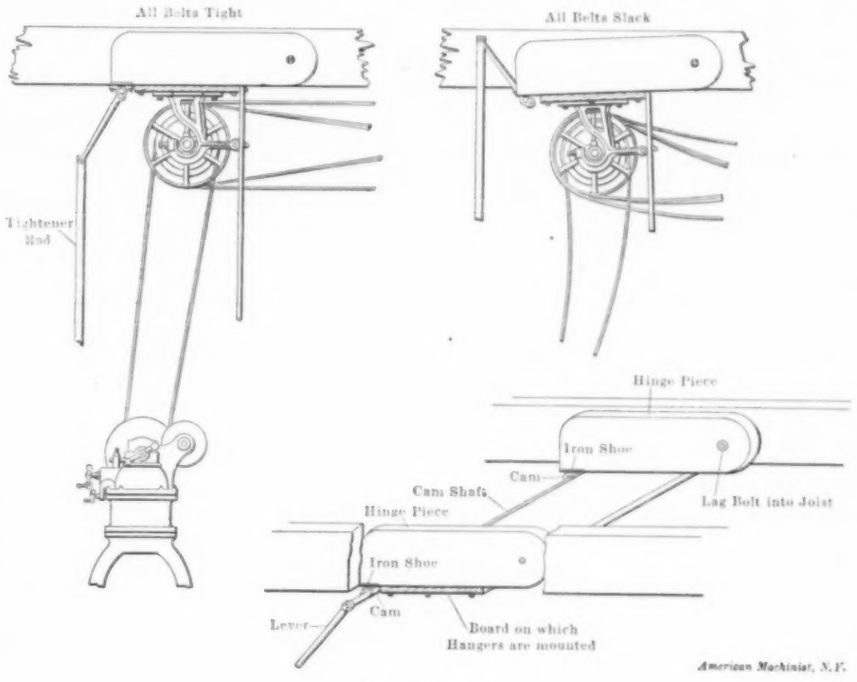
Coventry, England. T. B. G.

To Have Tight Belts, Slacken Them

There are few workmen who have not learned that, to have tight belts on a machine when using it, it is desirable to slacken them on leaving the machine, so as to allow the leather to shrink. This is accomplished on some machines by the use of an undersized idler, the belt running loosely when shifted on to the pulley of smaller diameter. This arrangement, however, is not easily adapted to lathe countershafts and others employing two or more belts to the line shaft and as many more down to the machine.

In a certain shop I saw a very simple but ingenious device that with the manipulation of but one lever slackens all the belts simultaneously. The workman on finishing at a given machine simply pushes up the rod hanging conveniently near, thereby slackening both the horizontal and vertical belts, allowing them to run loosely until needed again.

The accompanying drawing shows the device very clearly. The countershaft hangers are mounted on a heavy, wide board which is bolted to the two-hinged pieces, thus forming a unitary structure which may swing up or down on the lag



A BELT SLACKENER

bolts as fulcrums, the lag bolts being screwed into the joists as shown. Thus the countershaft structure takes a position, when lowered, that slackens all the belts, as already mentioned.

The raising and lowering is accomplished by means of the cam shaft and lever mounted in suitable hangers, or boxes, attached to the underside of the joists. The cams bear against iron shoes fastened to the underside of the free ends of the hinged pieces, and thus raise or lower these free ends with the result described. The lever on the end of the cam shaft is operated by means of the wooden rod shown.

The habit of slackening the belts on leaving the machine is readily acquired, the operation being as simple as shipping the belt. It is apparent too that a great saving is thereby accomplished both in wear on bearings and belts and a man's temper.

Sumter, S. C. S. C. MCKEOWN.

Discussion of the Previous Question

Letters from Our Readers Showing How Many Men of Many Minds Look upon Various Subjects Opened up in Previous Numbers

WE PAY FOR THESE ALSO

Hardness and Carbon Contents of Steel

Mr. Shore's last article on page 1066, Volume 32, Part 1, is based on an entirely new definition of hardness with which I cannot agree.

His definition might be summed up in the following: Hardness is the thing which the scleroscope measures and all other things are not hardness. For instance, he says: "The general theory that the hotter you heat a piece of steel the harder it gets, presumably is due to the fact that the prevailing opinion as to what hardness really is is not altogther correct." This means that the definitions given for hardness do not agree with the thing that he measures on the scleroscope.

In the next paragraph he says: "The belief that a high hardness must be accompanied by a crumbling up or brittleness is particularly wrong in dealing with metals, although it may not be so much out of place in minerals, for some of these will scratch the hardest steel while yet they are extremely brittle as a mass and have an insignificant strength or ductility." As though it were possible for hardness to be one thing in metals, another in minerals, and still another in another material, he would make us believe that hardness is not hardness when it is in anything else but steel or when it cannot be measured on his scleroscope scale.

Again he says: "High carbon steel when so much overheated as to crystallize very much, is very different from the same when heated at just the right heat." In this paragraph he would try to make us think that hardness ceases when crystallization begins in steel, or in other words, he is trying to give hardness a new definition.

The molecules of steel when heated to too high a temperature lose a part of their cohesive force and form into coarse crystals which are more easily separated than when the steel has not been heated up to this point. That hardness does not cease when crystallization begins, as he would like to make us think his scleroscope shows, is contradicated by himself in a later paragraph in which he says: "While it is true that crystallized steel may have particles quite as hard as one in a noncrystallized condition, etc."

He also shows that it is not hardness he means by the following paragraph: "The kind of hardness which is at the bottom of fine tools is one which combines also a vast amount of strength. The more strength the more effective will the hardness be." From this he proves that it is not hardness alone which he measures but a combination of hardness with toughness, as these are the two properties which meet at the correct point to give steel its greatest efficiency as a cutting tool, that is, it must be hard enough to cut another metal and it must also be tough enough to withstand strains put upon it by the cutting operation.

When steel is heated to the point of crystallization, the cohesive force which binds it together in a mass is reduced and the metal becomes brittle. This greatly decreases the toughness, tensile strength and elasticity of the metal. When the hammer or weight in the scleroscope drops on this crystallized metal, it pushes apart the particles that are held together by the weakened cohesive force and consequently it does not rebound as much as it would on a steel that has the greatest possible combination of cohesive force and hardness. In other words, it is this combination, or the resiliency of the steel that the scleroscope measures, but as the resilience travels in nearly a parallel line with the hardness up to the point where the steel begins to crystallize by overheating, it will for all practical purposes measure the hardness of cutting tools.

In speaking of determining the carbon in steel, Mr. Shore says: "The determination of carbon in tool steel by breaking it to permit a visual observation of the fracture has been in use among tool-steel makers for a great many years. The exact conditions requisite for the best results are kept secret by the experts who practice this art. This much, however, we do know, that although the readings obtained are more reliable than the average commercial chemical analysis, the differences in appearance are so trifling that they can only be discerned by the steel wizard."

The judging of the carbon content of steel by the fracture is something that is done very closely by the steel wizards, as Mr. Shore calls them. To become expert in this requires years of practice, as it requires years of practice to become expert in any other trade, but it is no more a secret than it is a secret for a mechanic in any other line of work to do jobs that the apprentice is not able to do.

Judging the carbon content by the fracture method, however, is not more reliable than the chemical analysis, as in all of the steel mills of the present day, the fracture test is used to get a quick knowledge of the carbon content; while the steel is yet molten. The fracture test is made by casting a test bar from the steel and fracturing it, when cold, to permit a visual observation. While the test is being made the steel must be kept molten in the furnace or crucible so that more carbon can be added, if necessary, before the metal is cast into ingots.

When, however, a definite knowledge of the carbon content of the steel is wanted, samples are sent to the chemical laboratory, but as the chemical analysis takes considerable time, the melt is cast into ingots before the carbon contents can be obtained and hence its percentage cannot be changed. Thus, it becomes necessary to judge the carbon by fracture while the mass is molten, but the chemical analysis gives the actual carbon content, whereas the fracture test is only guess work.

That the real chemist can get and weigh all of the carbon in any steel is shown by the discussion entitled "Analyzing for Carbon Content of Steel," by Philo Kemery, on page 798, Volume 32, Part 1. Here Mr. Kemery shows the two methods for chemical analysis, namely the gas analysis and the solution analysis, and he shows that these two methods, which might be considered the direct opposite of each other, give the same results as to carbon content when the analysis is carried on by a proficient chemist. When Mr. Shore says that one of his chemists only found 0.37 per cent. of carbon in a certain steel that all other tests showed to contain from 1.70 to 1.75 per cent. of carbon, then methinks he has been dealing with a would-be chemist or an apprentice in chemistry and not with a master chemist.

New York. E. F. LAKE.

A Brake for a Ship

On page 897 is a description of a "ship brake" which is to be tested by the Government.

Looking over my scrap book I came across a newspaper clipping dated August 18, 1882, and credited to the *New York Herald* (date not given).

This clipping described a "ship brake" precisely like the one mentioned in the AMERICAN MACHINIST. The account was given in considerable detail and also gave the results of several practical experi-

ments: which bears out the old adage, "There's nothing new under the sun."

Oshkosh, Wis. E. S. NEWTON.

Should Screw Threads Have a 60° Angle at Right Angles to the Helix?

The article in the AMERICAN MACHINIST, page 1045, Volume 32, Part 1, by L. E. Dudley presents the above question. My answer would be decidedly: Yes, because otherwise we will have a different angle for each varying ratio between the diameter and lead of screws, and accurate results would be unobtainable with thread-measuring instruments with pitch diameter-measuring surfaces of 60 degrees. I do not believe because the American Society of Mechanical Engineers show their theoretical diagrams parallel to the center line of the screw, that we should take a literal translation and make our screws and gages in a manner impractical to be measured, as the practice in measuring thread diameters in the *angle* is more important to interchangeability than any other part except the lead. On account of the able way in which Mr. Dudley introduced the subject I was sorry to see that he stopped where he did and omitted to express his views on the subject, as it seems from his acquaintance with the matter that he must have already made up his mind as to what ought to be done, and his opinion on account of his insight into the question should carry some weight.

No.	Outside Diameter and Thread.	Helix Angle.	No.	Outside Diameter and Thread.	Helix Angle.
1	0.073–64	4° 30′	9	0.177–30	4° 0′
2	0.086–56	4° 30′	9	0.177–24	5° 0′
3	0.099–48	4° 30′	10	0.190–32	3° 15′
4	0.112–40	4° 45′	10	0.190–24	4° 45′
4	0.112–36	5° 30′	12	0.216–24	4° 0′
5	0.125–40	4° 15′	14	0.242–20	4° 15′
5	0.125–36	4° 45′	16	0.268–20	4° 45′
6	0.138–36	4° 15′	18	0.294–18	4° 0′
6	0.138–32	4° 45′	20	0.320–18	3° 30′
7	0.151–32	4° 15′	22	0.346–16	3° 45′
7	0.151–30	4° 30′	24	0.372–18	3° 0′
8	0.164–32	4° 0′	26	0.398–14	3° 45′
8	0.164–30	4° 15′	28	0.424–16	3° 0′
			30	0.450–16	2° 45′

A. S. M. E. SPECIAL MACHINE SCREW HELIX ANGLES.

No.	Outside Diameter and Thread.	Helix Angle.	No.	Outside Diameter Diameter Thread.	Helix Angle.
0	0.060–80	4° 15′	16	0.268–22	3° 30′
1	0.073–72	4° 0′	18	0.294–20	3° 30′
2	0.086–64	3° 45′	20	0.320–20	3° 15′
3	0.099–56	3° 45′	22	0.346–18	3° 15′
4	0.112–48	3° 45′	24	0.372–16	3° 30′
5	0.125–44	3° 45′	26	0.398–16	3° 15′
6	0.138–40	3° 45′	28	0.424–14	3° 30′
7	0.151–36	4° 0′	30	0.450–14	3° 15′
8	0.164–36	3° 45′			
9	0.177–32	3° 45′			
10	0.190–30	3° 30′			
12	0.216–28	3° 15′			
14	0.242–24	3° 30′			

A. S. M. E. STANDARD MACHINE SCREW HELIX ANGLES.

However, as the society has given us the standard with very complete data, the matter ought to be put squarely up to them for settlement, so that the thread system will admit of no argument or discussion on this point.

I have already concluded to follow what seems to me to be the only safe way; that is, making all threads 60 degrees at right angles to the angle of helix of the thread and have compiled the accompanying table of angles from the formula, *Tangent of angle of helix at pitch line*

$$= \frac{Lead}{Pitch\ Dia. \times 3.1416},$$

using in all cases the maximum pitch diameters for screws upon which to base the formulas by which to set a swiveling thread-cutting tool as mentioned by Mr. Dudley when cutting threads. I think that this method should be universally adopted and that it should receive the official approval of the American Society of Mechanical Engineers, for while with the new table the difference in threads produced by both methods is very slight, I can readily see where it would be appreciable on fine gage work.

Brooklyn, N. Y. R. K. MELVIN.

A Suggested Change in Our Patent System

It was with a great deal of pleasure that I read your editorial on "A Suggested Change in Our Patent System," and I believe that thousands know, as I know, that the patent laws of the United States are a farce, and the only protection that a man has who patents an invention, is unlimited capital to back it and to use in fighting unscrupulous corporations and infringers.

Some years ago I made a device to remove the sand from the rails of a railroad after the engine had passed over it, increasing the tractive power. The foreman wanted to use it, so he tried one. It was successful and they put it on all their engines. When I wanted some recompense for my invention I was referred to the master mechanic, who referred me to the general manager, who referred me to the directors, and as I was and still am poor, I could do nothing. I will say, parenthetically, that recently I noticed in the telegraph dispatches that a law suit against a railroad had been settled after *thirty years'* litigation.

A particular friend and shop mate made an improvement in a machine made by a trust and had it patented. He wrote them and they offered him a stipulated sum for all they used in their machines for 5 years. How many did they use? Not one; but beginning the day the five years were up they put it in every machine they turned out.

Recently I have received through a patent lawyer in Washington, a certificate of patentability on an improvement in automobile structure; by my device I can save weight, friction, noise and an expense of $10 to $15 on each one. Now there is hardly an automobile manufacturer in the country that would not pay at least $1 royalty on my invention and be glad to do it, but if I show it to A, he thinks it a good thing and will adopt it. Then I show it to B and C, who declare they will adopt it if I can prove to them what I say, so they meet casually, or otherwise, and the matter comes up.

A says, "I am making so many machines a year, and it will cost me so many thousand dollars;" B and C make their statements as to the cost to them, which would represent a few thousand more. Finally they want to know who the inventor is, and they find he is a poor machinist in the employ of So and So and has a hard time to make a living for himself and family and could not fight a suit for using his invention as an infringement suit, and they all agree to go to using it, and if he wants to he can bring suit and stop them. They go to using it and the inventor is helpless, the man who has the brains and the ingenuity to create something new and useful. My model and drawings are resting quietly at my home in the bookcase and will stay there. If my invention would rest the feet of a tired shop girl, the eyes of a poor seamstress, or was a new anesthetic in a cure of tuberculosis, I would gladly and freely give it to the world, but when it would only help those who are already millionaires, or on the highroad to millionairedom, and who I know would not stop at forgery or perjury to steal the child of my brain, I certainly will not put the temptation in their way.

We have manufacturers and trust magnates who are high in manufacturing, industrial, commercial and social affairs, who are as grand old pirates as ever scuttled a ship or cut a throat or made an unfortunate walk the plank.

I hope that this is the beginning of a reform and that many more able articles will appear in the AMERICAN MACHINIST. I don't know of any better paper to take the lead, nor a better class of papers than the technical publications to bring this reform about. As for me, I am only a

Irvington, Ind. P. I.

Crowning Pulleys

Reading the several articles that have appeared from time to time in the AMERICAN MACHINIST about crowning pulleys in an engine lathe with special taper attachments, attachments with weight and cams, has caused me to wonder that none of these writers had used the simplest method of all. By using two tool posts, one in front, and one in the rear with an

inverted tool, pulleys can be crowned at any angle by simply shifting the tailstock the desired amount.

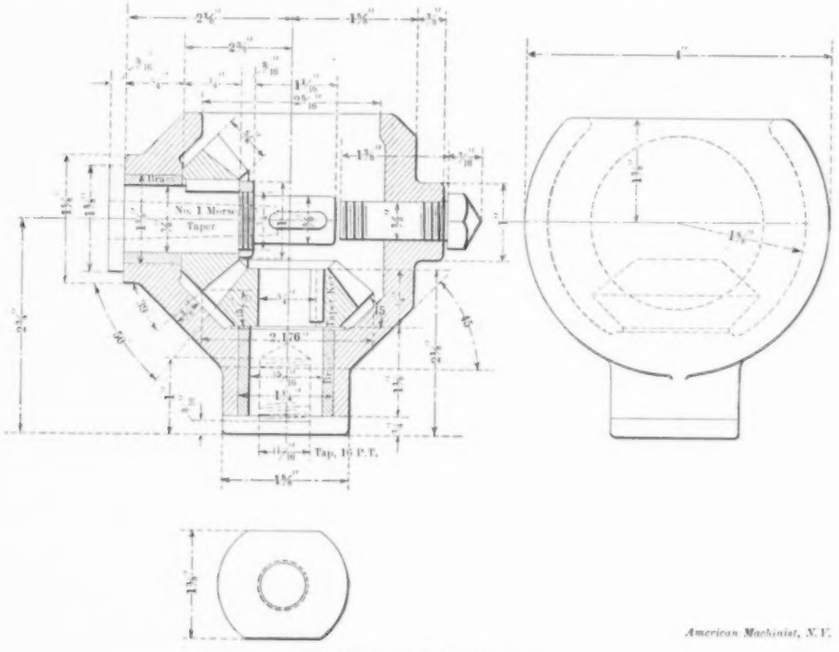
With this method the tool travels but half the width of the pulley, reducing the time practically half.

Poughkeepsie, N. Y. G. W.

Right Angle Drilling Attachment

On page 981, Part 1, I noticed a right-angle drilling attachment for a radial drill. The line cut shows an attachment which we are using on our air drills—the same idea exactly which we made some time ago. The gears are 8 pitch 16 teeth.

We have found it to be a very useful attachment around the erecting floor for drilling where there is not space enough for the air drill to work.



ATTACHMENT FOR AIR DRILL

Dundas, Can. H. A. BERTRAM.

Hardening Copper

The process for hardening copper given on page 862, Vol. 32, Part 1, is interesting as showing the hardening and strengthening influence of a small proportion of some element in an alloy other than the well known results thus achieved in the various steels.

In connection with this subject it is interesting to note European practice with reference to furnace copper. Arsenic is hardly an appreciable impurity of furnace copper, but it now appears that the electrolytic copper coming so generally into use is too pure for certain purposes. On the Prussian railways it has been noticed in recent years that the number of fractured locomotive stay-bolts was peculiarly increasing. Investigation showed that the increased number of fractures followed the increasing use of electrolytic copper, and that out of 23 broken stay-bolts examined, 21 were of this metal and only two of furnace copper. Of the electrolytic specimens only one contained arsenic which was present in all of the furnace copper bolts examined. The high quality of copper containing arsenic had already been recognized and railways in Italy and the British possessions specify 0.15 to 0.55 per cent. of arsenic as necessary in all copper purchased.

Brooklyn, N. Y. W. MOR.

Hobbing Machines

Is the generating machine for hobbing gears a failure? H. H. Wilson asks the question on page 754, Part 1, and proceeds to answer it, in one way. Now, it appears to me that quite a lot of people are likely to raise vigorous objections to Mr. Wilson's conclusions on the subject.

It is the maker of machine-cut gearing who must decide on the merits of a particular system, and his decision must be influenced by considerations of productive economy, which are not always in harmony with his technical ideals.

I cannot reconcile any of Mr. Wilson's theories with such observations as I have been able to make during several years' experience in the manufacture of large and small gears by a hobbing process. The cause of the flats which appear on hobbed gear teeth is precisely that which Mr. Thompson explains in his article. The importance of these flats is liable to be exaggerated; they are scarcely noticeable except in the case of pinions with very few teeth. It must not be forgotten that the flats are tangents to the generated tooth curve, and very soon disappear into the latter when the gears are set to work.

Most gear cutters will agree that there is a tendency for chips to clog the hobs when dealing with certain kinds of steel, but the roughness of tooth which results bears no relationship to the flats described by Mr. Thompson, and usually consists of irregular scratches and scores. The proposed cure appears to me too complicated for practical use, and could only be applied for repetition work on small blanks. It is quite enough trouble to deal with the lubricant when applied in the ordinary way, and it is astonishing what a quantity will disappear in a short time, despite all precautions. To increase the pressure to ten pounds would, I imagine, keep the receiving clerk and cashier pretty busy—with oil! Moreover, the trouble is practically non-existent in general gear manufacture, being confined to certain steels used for motor cars.

Mr. Wilson's second point merely shows that he has been unfortunate in the selection of machines. There are plenty of gear hobbers on the market which show very little of the movement described, and it is the gear cutter's business to take care of wear and make such adjustments from time to time as are necessary.

Finally, with reference to troubles which arise from torsion of the hob stock, I would suggest that if the dimensions cannot be increased the material should be improved. Personally, I find it pays to use the best steel in this position, preferably an alloy with the highest possible elastic limit consistent with reasonable toughness. But if the hob stock is noticeably weaker than the rest of the machine, why should it be necessary to re-design the whole in order to bring the offender into line? I regard the hobbing process as one which is reasonably accurate for all classes of gearing, while it possesses certain advantages as regards uniformity of division and tooth thickness which fully compensate for any slight faults in superficial finish.

As with all gear-cutting systems, the machines must be strong, rigid and accurately finished. Given all these and the right kind of skilled labor in the shop, success will be found to depend on the design of the hobs and the relationship between tooth hight and pitch.

The necessary inclination of the hob axis when cutting spur gearing is the one undesirable feature of the process, and even this objection disappears if the teeth are cut double helical instead of straight.

Yiewsley, England. PERCY C. DAY.

According to statistics collected for THE MINERAL INDUSTRY, the total lead production of the United States in 1908 was 314,067 short tons, worth $26,381,628. The 1907 production was 350,130 short tons, worth $37,288,845.

AMERICAN MACHINIST

Issued Weekly by the

Hill Publishing Company

JOHN A. HILL, Pres. and Treas. ROBERT MCKEAN, Sec'y.

505 Pearl Street, New York.

Correspondence on mechanical subjects solicited and paid for. Name and address must always be given—not necessarily for publication.

Subscribers can have address changed at will. Give old and new addresses.

Subscription price $4 per year, postage prepaid, to any post office in United States, United States possessions and Mexico. $5.50 to Canada. $7 in all foreign countries except Europe and British possessions in Eastern Hemisphere.

Hill Publishing Co., Ltd., 6 Bouverie St., London, E. C., will serve all subscriptions for Europe and British possessions in Eastern Hemisphere. Price 30 Shillings for England. For all other countries in Eastern Hemisphere, 35 Shillings.

Entered at New York Post Office as mail matter of the second class.

Cable Address, "MACHINIST," N. Y.
Business Telegraph Code.

CIRCULATION STATEMENT

During 1908 *we printed and circulated* 1,205,750 *copies of the* AMERICAN MACHINIST. *Our circulation for June,* 1909, *was (weekly, monthly and European)* 91,250.

July 1	34,000
July 8	19,000
July 15	19,000
July 22	19,000
July 29	19,000

This paper reaches 34,000 *separate readers each month and* 19,000 *each week.*

None sent free regularly, no returns from news companies, no back numbers. Figures are live, net circulation.

Contents

	PAGE
Gages Used in Making Comptometers	181
Errors in Scales	186
United States Navy Specifications for Tool Steel	187
Piece Work—Noisy Gears and the Question of Experience	190
The Making of Automobile Tires	191
An Interesting Gas Engine	197
Fixture for Steam Hammers	197
Buying Carbon Tool Steel on Specifications	198
An Adjustable Angle Plate	199
The Premium System of Wage Payment	200
Employing Only Employed Men	203
The Man Who Knew It All	203
The Worcester Trade School	205
Our Patent Laws	207
Practical Letters From Our Readers: Manufacture of Eccentric Rings....Slotting a Blank Holder in a Punch Press....An Arc Turning Tool....Jig Boring Tool....A Spanner Wrench for Shafts....An Adjustable Square....Indicator for Piston Work....Tight Belts	207-209
Discussion of the Previous Question: Hardness and Carbon Contents of Steel....A Brake for a Ship....Screw Threads....A Suggested Change In Our Patent System....Crowning Pulleys....Right Angle Drilling Attachment....Hardening Copper....Hobbing Machines	210-213
The Metric System Unwept, Unhonored and Unsung	213
The Training of Apprentices	213
New Tools and Machine Shop Appliances	214

The Metric System Unwept, Unhonored and Unsung

No finer example of an anti-climax was ever seen than the result of the recent attempt to revive interest in the adoption of the metric system through the agency of the American Society of Civil Engineers.

A special committee was some time ago appointed by that society to report upon the Status of the Metric System in the United States. Of course, no thoroughgoing metric advocate can be expected to permit others to set bounds to his advocacy of his pet hobby and the committee, ignoring the evident purpose of the society which appointed it, begins its report with 3½-page sketch of the history of the system, following this with two pages setting forth its status in this country and then, after devoting half a page to the objections which have been made, gives twelve pages to a re-statement of the time-worn and weather-beaten reasons for the adoption of the system, including a choice collection of the fables and fictions on which the metric case has always rested.

Our readers have not forgotten the activity which followed the introduction of a bill for the adoption of the system in Congress in 1901, and especially they have not forgotten the great discussion which took place at the fall meeting of the American Society of Mechanical Engineers in 1902, when other topics were pushed bodily aside and an afternoon and evening were devoted to the exclusive discussion of what was then the leading topic of interest, this discussion being followed by a referendum ballot among the members.

Neither can they have forgotten the activity of the National Association of Manufacturers in organizing opposition to the system and in sending delegation after delegation to Washington to appear before the House Committee on Coinage, Weights and Measures, in opposition to the bill then before Congress.

These are but two illustrations of the universal interest which was then taken in the subject. Discussions followed by pollings of the members were held by society after society. The technical press was full of it, while the *New York Herald* undertook an active campaign in its favor.

We refer to these things in order to emphasize the final collapse of the agitation as it took place at the annual convention of the American Society of Civil Engineers, held at Bretton Woods, N. H., July 6-9.

The report of the committee was printed in preliminary form in the *Proceedings* of the society last October and formally presented at the meeting held in January, the action taken being to place the report upon the slate for discussion at the annual convention just passed.

From the report of the meeting which appears in the issue of our contemporary, *Engineering News,* for July 15, we extract the following, the single sentence given, being the entire report of the proceedings as they related to the committee's report:

"Of two committee reports scheduled for presentation, the one on the Status of the Metric System (*Proc.,* Am. Soc. C. E., Oct., 1908) gave rise to no discussion save a written communication which was not read."

When a great organization like that of the civil engineers, which has long been looked upon as one in which the metric propaganda has made dangerous progress, permits an occasion like this to pass in silence, we can only conclude that the curtain has been wrung down and the lights put out.

The Training of Apprentices

There is no subject more worthy of deep and earnest consideration by all who are interested in the welfare of the machine business than the training and education of apprentices. And instead of being a question to study at leisure and theorize over when there is nothing else to do, it is a problem that confronts us at the present moment, perhaps more forcibly and persistently than any other. The seed sown by many manufacturers in refusing to take apprentices, either on the ground that they could not afford it, or that they could get boys other men had trained, is bearing its logical harvest, and these same manufacturers are finding that the supply was not unlimited.

Most employers are agreed that the first thing is to pay a boy enough to live independently of boarding at home. This makes a larger and often a sturdier set of boys available and has much in its favor that offsets the difference between the old and the new rate of wages. But, having the boy, the next question is how to train him.

The shop school is out of the question for the small shop, and all are agreed the night school is a relic of the past. The Cincinnati plan of sending the boys to the public schools in classess of a size that can be readily handled so as to give as much individual instruction as possible, has much in its favor, especially for the small shop. The time suggested in the present plan, one-half day a week, may need to be increased for the best results, but that remains to be proved.

The critical part of the whole scheme is the teacher, and on this the success or failure of the plan may be said to hinge.

It is fairly safe to say that any college man is pretty sure to be a failure in this position and the average teacher is sure to make a mess of the whole thing in short order. Either of these is sure to lose sight of the fact that the idea is to

train machinists and not to educate engineers. That is where the average instructor falls down.

This means that the teacher must know just what training a good machinist needs in the way of mathematics and the other branches, and if he has any doubts it is safer to cut out all except such arithmetic as is used in shop problems and the reading of drawings. It is better to drill a boy over and over in figuring change gears for a lathe, milling machine, or gear hobber, or similar shop problems, than to try and give him a smattering of geometry, or have him figure out stresses in bolts or beams. Teach him the principles of levers so he will not tackle the wrong end of a crowbar, or of ropes and tackle so he can hoist a machine into place with a few men, but forget the radius of gyration and similar bits of information that in all probability will be absolutely useless to him.

We would not for a moment discourage any boy who wants to study mechanics, mechanical drawing, or higher mathematics, but rather help him in any way possible. But give the boy the things he needs to be a good machinist *first*, drill it into him so it becomes second nature, and then, if he is so inclined, he will do the rest himself, or will find the means of acquiring the desired information.

The training of boys to be machinists is more of a problem than it may appear, and it will be interesting to watch the courses of study which are finally adopted in Cincinnati and other cities who try this plan. And it is always necessary to bear in mind that the engineers are being well cared for by the technical institutions, while this is an entirely different problem.

An American Exhibition in Berlin

We are in receipt of information relative to an American exhibition which is to be held in the city of Berlin during the months of April, May and June, 1910, the location being at the well known exposition palace which includes about 110,000 square feet of floor space.

The plan of organization is somewhat different from that which usually prevails at affairs of this kind, especially as regards the provision for incidental expenses which are commonly so annoying.

Under the plans proposed such incidental expenses as decorations, foundations, carpeting, water, heat, light and janitor service are included in the price of space per square foot, which is to be $4. This charge also includes insurance against fire and theft to the extent of $25 per square foot, the net result being that the exhibitors will be put to no expenses other than those of rental, transportation, installation and demonstration.

The Hamburg-American and the North German Lloyd steamship companies have granted a reduction of 20 per cent. in the freight charges on exhibits both ways. The American headquarters of the exhibition are located in the Hudson Terminal building, 50 Church street, this city, where Max Vieweger is manager.

New Publication

GAS ENGINE THEORY AND DESIGN. By A. C. Mehrtens. 256 5x8-inch pages; 135 illustrations and 92 details of engine design; indexed. John Wiley and Sons, New York City. Price $2.50.

This work was originally prepared as a text book for engineering classes at the Michigan Agricultural College, although the author's preface states that it is for students, draftsmen, engineers and operators of gas engines. The breadth of the field for which it is written is a partial excuse for considerable material which is only remotely relevant to the subject of theory and design. See chapters 2 and 3 devoted to historical references and applications. The data of installations and aggregate horsepowers hold true only for a short interval, and indeed at this time undoubtedly need revision. However, this is only a small point to urge against the book for in the main it is well written, with material well selected, and presented in a clear, easy, concise style. If anything, it is too elementary rather than the reverse. The text occupies 181 pages; the balance of the book is devoted to the question of design. Details are presented of a 2½-horsepower vertical engine and a ½-horsepower horizontal engine. These appeal to the reviewer as an unnecessary feature. It is far better to present fundamental principles of design than details thereof. Such details tend to make a student a mere copier, instead of developing engineering judgment. From a draftsman's standpoint the drawings are only indifferently executed, and many necessary shop details are lacking.

Joseph W. Thompson

Joseph W. Thompson, the veteran inventor and one of the pioneers in steam-engine development, died at his home in Salem, O., on July 15.

Mr. Thompson was born in 1833, in Columbiana county, O., and at the age of 18 apprenticed himself to Samuel C. Taylor, who owned a rather crude machine shop in Salem, O. On the termination of this apprenticeship, he entered the employ of Sharp, Davis & Bonsall in 1854, a newly organized company operating what was then considered a modern plant. With the exception of a brief period he continued with this company and its successor, the well known Buckeye Engine Company, the remainder of his active career, which terminated several years ago owing to the infirmity of advanced age.

The first notable work done by Mr. Thompson was in 1865, which consisted in designing patterns for upright blowing engines for blast furnaces.

In 1871, the Buckeye Engine Company was organized and immediately set out to build an "automatic cutoff" engine. The task of designing and building an engine of the type desired, that would prove correct, fell to Mr. Thompson, and his experimental work, begun in 1872, proved very creditable, although all of the results desired were not attained in his design until 1875, when a large engine embodying principles of construction since found correct and adhered to, was exhibited in Cincinnati, and a year later a still larger engine, exhibited at the Philadelphia Centennial, attracted universal attention and praise. Since that time only minor changes have been made in Mr. Thompson's construction by the Buckeye Engine Company, of which the recent substitution of a round or piston valve for the box slide valve, is the most important.

Many minor engine details and shop appliances were invented by Mr. Thompson, not all of which were patented, but the one invention that probably brought his name before the engineering world more than any other achievement was the Thompson indicator. Its invention was the result of Mr. Thompson's experience with a Richards indicator in testing the small high-speed engines then being built. To his mechanical taste the Richards indicator was a very defective instrument, and in designing his own he dispensed with two-thirds of the weight of his moving parts, accomplishing the "parallel movement," which was the occasion of so much disturbing weight in the Richards type, by a much simpler device. As soon as the improvement became known and its superiority realized, it came rapidly into use, and is at present a standard indicator in the engineering field, being manufactured by the American Steam Gauge and Valve Manufacturing Company.

Personals*

First Lieutenant Mark L. Ireland, stationed at the Frankford arsenal, has recently been transferred to the Watertown arsenal, Waterstown, Mass., connected with the ordnance department.

E. H. Fish, instructor in mechanical engineering at the Worcester Polytechnic Institute, severs his connection with that institution to become director of the newly organized Worcester Trade School, to which he was elected at the meeting of the trustees, held on July 17. Mr. Fish brings to the place an abundance of experience in both educational and practical lines, and his election to the position of director of the new school is looked upon with much favor in all quarters.

*Items for this column are solicited.

New Tools and Machine Shop Appliances

Showing New Ideas in Machine Shop Equipment That Make it Possible To Do Better Work at a Reduced Cost

THE LATEST INFORMATION

The "Marvel" Lathe

The illustrations that follow show the latest product of the Lodge & Shipley Machine Tool Company, Cincinnati, O., being known as their "Marvel" lathe which they have been trying out for some time. This differs from the usual lathe for producing duplicate work from bar stock, it being designed to have the pieces cut to length before comiing to the lathe instead of handling them from bar stock. It also has its turret tool holder revolving in a vertical instead of a horizontal plane as is usual.

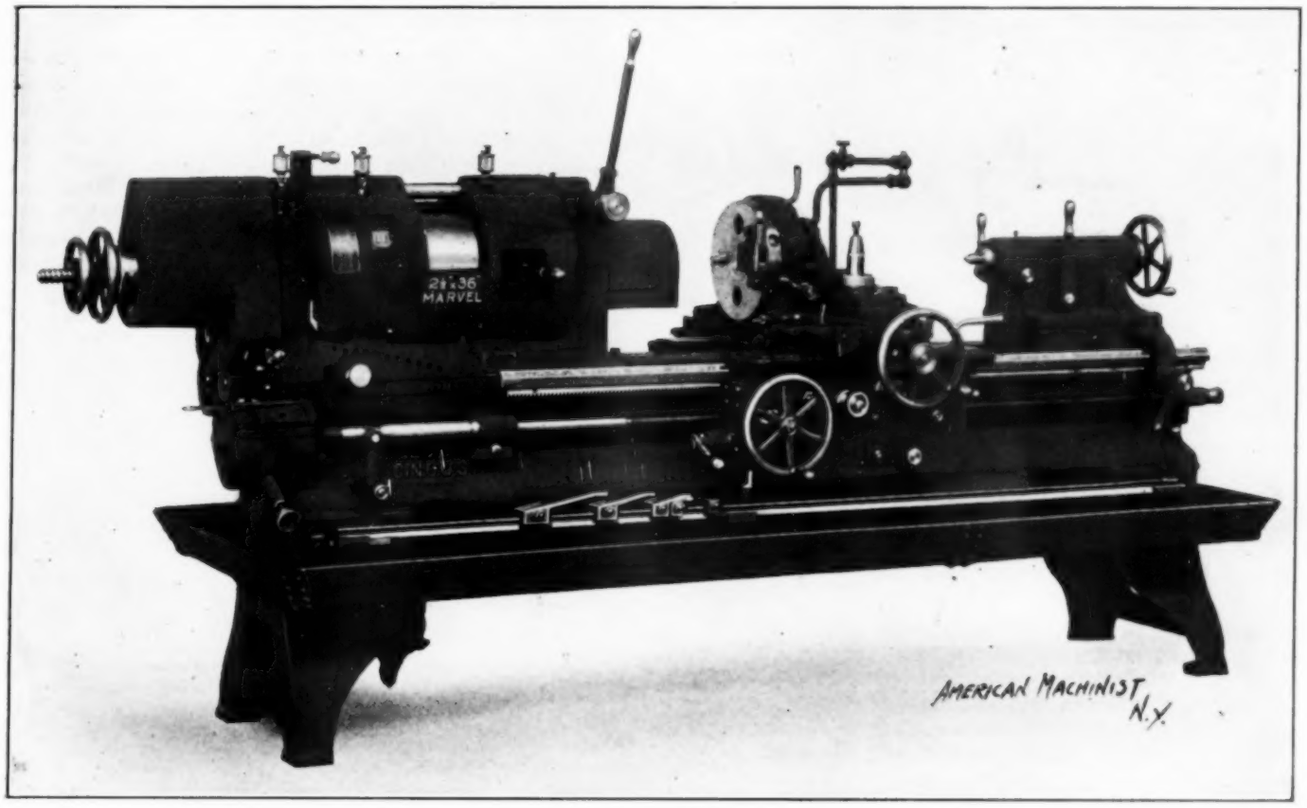


FIG. 1. THE 2½X26-INCH "MARVEL" LATHE

The general design of the headstock is similar to their single-pulley drive lathe with the exception of having a very large spindle to accommodate the draw-tube which is used in connection with the collets for holding the stock. This is controlled by the lever at the front of the headstock and is very convenient for the operator. The coarse-pitch screw shown at the back of the spindle is a center stop for the stock and is adjusted and locked by the two hand wheels shown.

Figs. 2 and 3 show the interesting details of the carriage which, in addition to bearing on the two outer V's, also has a vertical bearing against the inside of the bed at the back. There are two independent ways planed on the bridge, one for the turret tool-holder slide and the other, raised considerably above the first named, for the tool blocks. The front tool block has a cross slide to assist in adjusting the tool while the rear tool block is fitted with the heavy tool post shown in Fig. 3.

The turret tool slide is held in the lower ways and has four holes for tools. This is locked by means of a spring plunger provided to center it accurately with the work. In addition to holding boring tools, special necking and cutting-off tools can be used in the holders shown in both Figs. 1 and 2. Both the main carriage carrying the two tool blocks and the turret tool holder are moved by the hand wheel in front, although both movements are entirely independent of each other.

Fig. 3 shows the automatic stop used in connection with the cross slide for insuring duplication of diameters with either the front or back tools. These stops are located in the T-slots of the bar which runs parallel with the slide and work in connection with the steel fingers shown on the slide itself. The front finger is positively located but the other can be adjusted as desired. At the back of the bar carrying these stops is a pair of steel clutches, one of which has the spiral grooves shown, which correspond in number with the slots in the bar. On the forward movement of the slide a spring is compressed and the clutches held together so that a continued movement causes the bar carrying the stops to be revolved, automatically bringing the right stop into position for the next diameter to be turned. On the return movement, the pin rides over the groove and drops into position for the next forward movement.

The lengthwise stops on this lathe can be seen along the front of the bed in Fig. 1, being bolted to a bar and so designed that they telescope or nest one inside the other, the carriage stop being so arranged as to make contact with one after the other as desired. When contact is made with one of these stops the lower bar is moved until the lever which con-

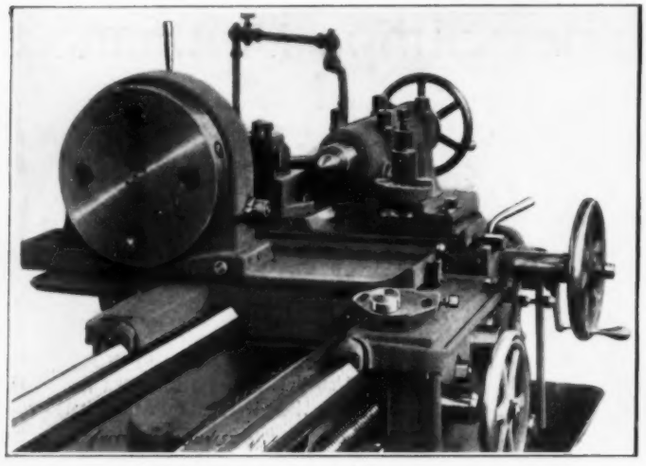


FIG. 2. THE TOOL TURRET

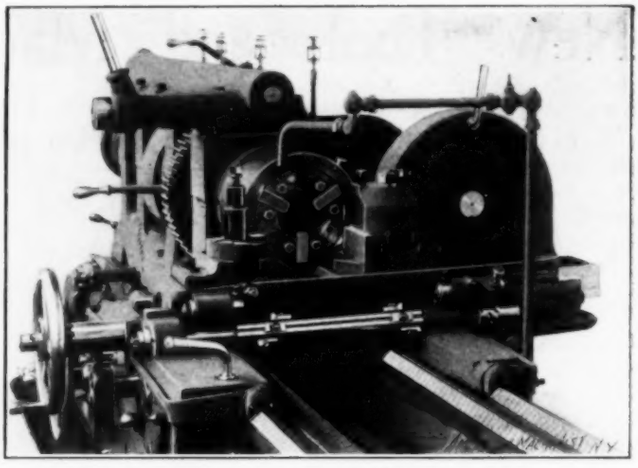


FIG. 3. THE CROSS FEED STOPS

nects it with the clutch on the lead screw is moved sufficiently to disconnect it. As soon as the stop on the carriage is raised out of contact, a spring forces the stop bar back and again engages the carriage, which operates until the next stop is reached.

In this lathe a tool will turn any number of diameters to any desired shoulder length within the capacity of the machine and not exceeding the number of stops furnished. This is built in three sizes, 2x24, 2½x36 and 4x48 inches, each machine being equipped with a full set of jaws for holding any diameter within its capacity.

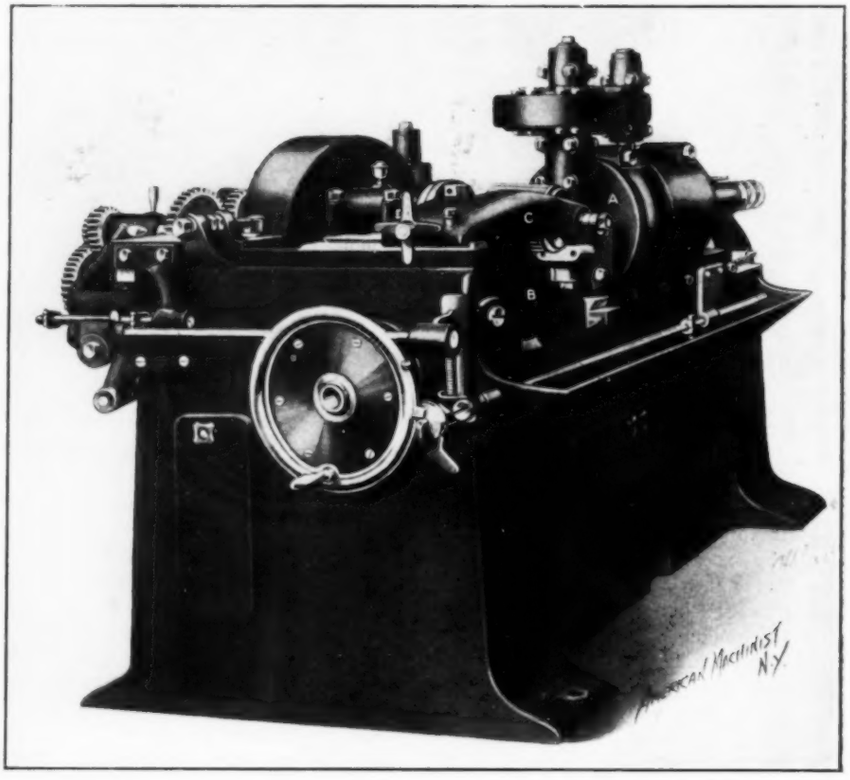
Lees-Bradner Gear Hobber

The design of the gear-hobbing machine shown herewith is such a departure as to attract attention, and many of its details are interesting. It is designed for hobbing spur, spiral and worm gears and threading worms. It will handle spur and spiral gears not over 14 inches in diameter, or over 4 diametral pitch; worm gears of the same diameter not over 1 inch circular pitch, and worms of 1-inch circular pitch and any lead, and not over 8 inches long and 8 inches diameter, all in steel. The machine is back-geared 8 to 1, is driven by a three-step cone located midway between cutter and spindle mechanisms, and the larger the diameter of gear to be cut the closer the cutter is brought to the original point of power. The screws used for feed and head slides both operate with a draw pull.

The swivel head *A* has a swing of 180 degrees without overhang. The swiveling mechanism consists of one pair of bevel gears inside the large cylindrical head, which in turn fits in another cylindrical bearing on a slide, the two being rigidly locked together by bolts at each end. No balance weights are necessary, and ample adjustment is provided for moving the hob on the cutter longitudinally. All movements are in one direction in all operations, to eliminate back lash, and the machine can handle a six-tooth, 70-degree, right-angle spiral as readily as a gear of a large number of teeth, by using a compound indexing gear of two distinct ratios. Should an odd gear be needed without the necessary hob being available, a single cutter can be used.

The work spindle and arbor are horizontal, being mounted on slide *B*, and the arbor is rigidly supported at both ends, the outer support being shown at *C*. This is especially important in hobbing a spiral gear, and owing to the design the work is held close to rotating mechanism; and as the spindle has a very accurate independent rotary adjustment, a relocation for tooth to cutter can be made.

In order to have the adjustments readily operated for duplicate work without having to watch the graduations after a setting is made, a micrometer is provided with the graduations on a disk 6 inches in diameter, which is locked with a thumb screw at zero when starting to take the reading. The setting for the depth of the cut is taken and a stop-rod collar is adjusted. The original feature of this mechanism is that the slide can now be backed away to any distance and then returned to its original setting to a positive stop without attention to the graduations, although should the operator wish to set the cutter



GEAR-HOBBING AND WORM-CUTTING MACHINE

in or out a few more thousandths the original reading is visible and can be worked from.

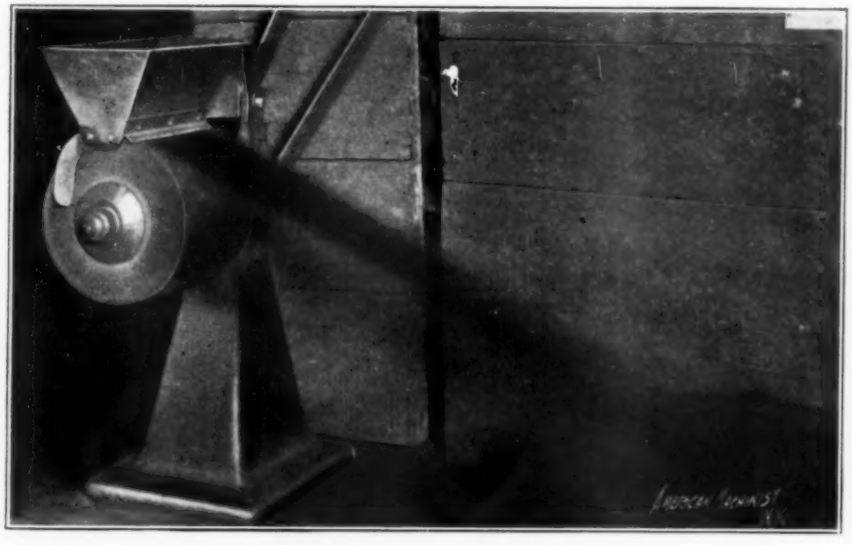
A single cutter is used for cutting worms. This runs from 75 to 117 revolutions per minute, the worm being rotated with the necessary lead, the rigid cutter head eliminating the annoyance of thin and thick threads. The worm is rotated by change gearing, ample provision being made for correct rotation to suit large and small diameters of work. The worm can be mounted on a shank arbor or on one or two shank centers, or held with a draw-in collet with either bush or center at the other end.

All the mechanism is in one horizontal plane and every part can be readily reached, adjustments being provided especially for the rotating worm and gear to positively take up any back lash. The chips are readily disposed of without coming in contact with any moving part and are removed by taking out a pan located directly back of the door in the machine, this chip pan and the receptacle for oil being the only parts inside the machine—even the pump being located outside and below the oil supply, which obviates the necessity of priming of the pump. As the work spindle has a 3-inch bore, gears on a shaft can be either held in the spindle with a draw-in collet, or can be held on one or two centers.

In operating the machine the necessary change gears are placed to suit the work to be cut. The depth is obtained by adjusting the head, at which time the micrometer is set and the work is fed across the cutter head. At the completion of the cut the main drive is automatically tripped and all mechanisms stop in unison, which is absolutely necessary in cutting a spiral gear, and relieves the operator of constantly watching the work and having to stop the machine. This is built by the Lees-Bradner Company, Cleveland, Ohio.

Bilz Sand Mixer and Sifter

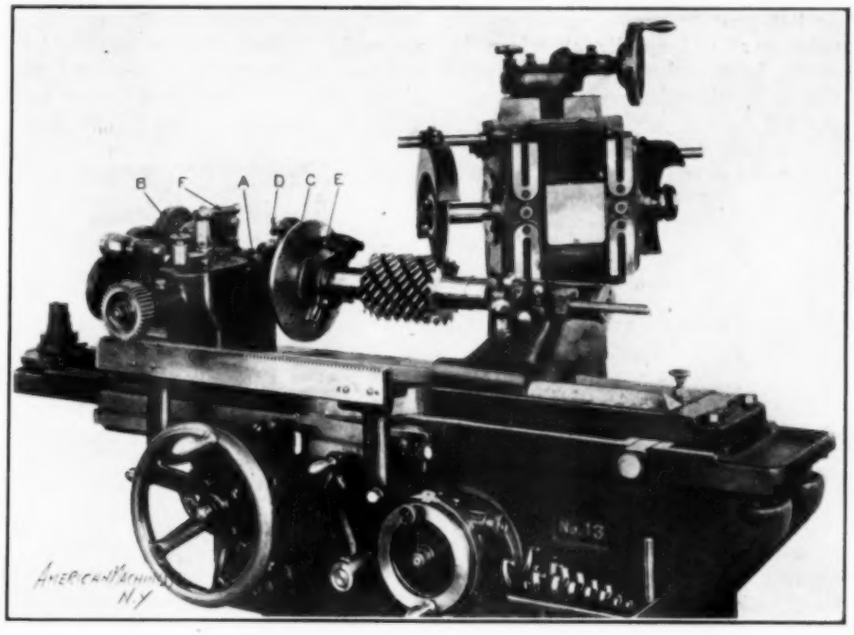
This is a novel device which is simplicity itself and consists of a stand carrying a rapidly revolving wire brush over which is mounted a closely fitting hopper. All that is necessary is to have the sand shoveled into the hopper and the revolving brush does the rest. This is said to thoroughly mix the sand and sift it at the same time, and in addition to this, effectually separates the sand from any foreign matter. Broken wires, nails, wood and other pieces of foreign matter are picked up by the wheel and thrown farther than the sand, so that it becomes an automatic separator and does not require the use of any sieve. Its simplicity will appeal to all foundrymen. It is being marketed by Walls, Bray & Co., 83 Walker street, New York City.



THE BILZ SAND SIFTER AND MIXER

Hob Grinding Attachment

The Brown & Sharpe Manufacturing Company, Providence, R. I., has brought out an attachment for accurately sharpening spirally cut hobs, either right- or left-hand, by grinding the faces of the teeth. In many respects it resembles closely the design of the spiral head employed on universal milling machines made by this company.

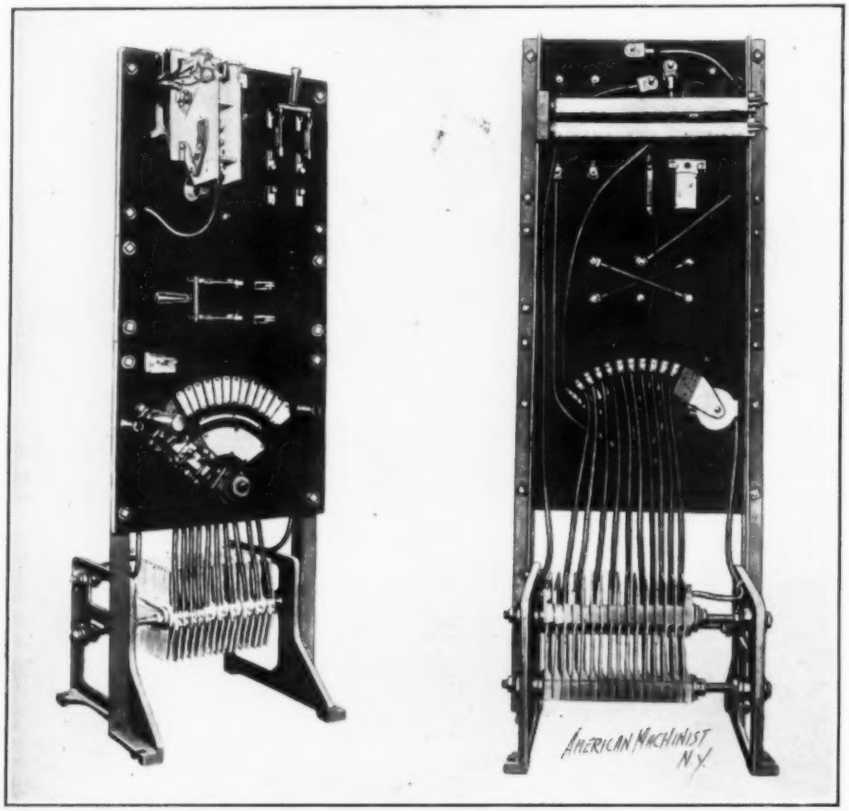


HOB-GRINDING ATTACHMENT FOR BROWN & SHARPE GRINDER

The gearing is of the same general order and the combination of gears furnished have the same numbers of teeth as those of the spiral head. Therefore, a hob grooved on a Brown & Sharpe milling machine can be ground accurately by the use of this attachment. It is driven by means of a stationary rack which is fastened to the front of the machine and upon which a pinion revolves as the table is moved longitudinally. Suitable gearing in the attachment rotated by the pinion on the rack causes the arbor supporting the hob to revolve as the table advances. In such a manner the correct lead of the grooves is maintained and the face of each tooth is ground an equal amount. In the case of hobs having very short or very long leads the gearing can be compounded so that the correct rotating of the hob will be maintained.

A fine adjusting screw *A* provides means for setting the face of the teeth to the wheel, and thus regulates the depth of cut. The position of the wheel should not be changed after being once set to grind the face of the teeth radially.

Reversing lever *B* provides means of reversing the direction of rotation of the spindle in order that hobs of either right- or left-hand spiral may be ground. The reversing mechanism consists of a pair of bevel gears situated on the driving-pinion shaft and revolving with it. These gears may be slid along the shaft by means of the reversing lever in such a manner that either gear may be made to mesh with another bevel gear located between them. This last gear transmits motion to the change gears and spindle, therefore, by reversing its direction of rotation that of the spindle is likewise reversed.



NEW TYPE OF MOTOR STARTER

Two index plates are furnished with the attachment by means of which hobs from 2 to 20 grooves can be ground, one of which *C* is shown in place. These plates are free to revolve upon the spindle and are driven by means of a small steel pin *D* that automatically drops into the holes of the plate when brought into correct position. A pin *E* on the front of the plate provides means of fastening the adjustable dog that drives the above.

The attachment is very rigid, compact and simple and can be quickly placed in position or removed from the machine. It is clamped to the face of the table by means of a single lever *F*. The driving mechanism or rack is fastened to the frame of the machine by means of two bolts that can be quickly put in place or removed. The regular footstock furnished with the machine is that used for the attachment. A saucer-shaped grinding wheel is employed and all grinding is done on the convex side of the wheel. A table of gears and spirals is sent with each attachment.

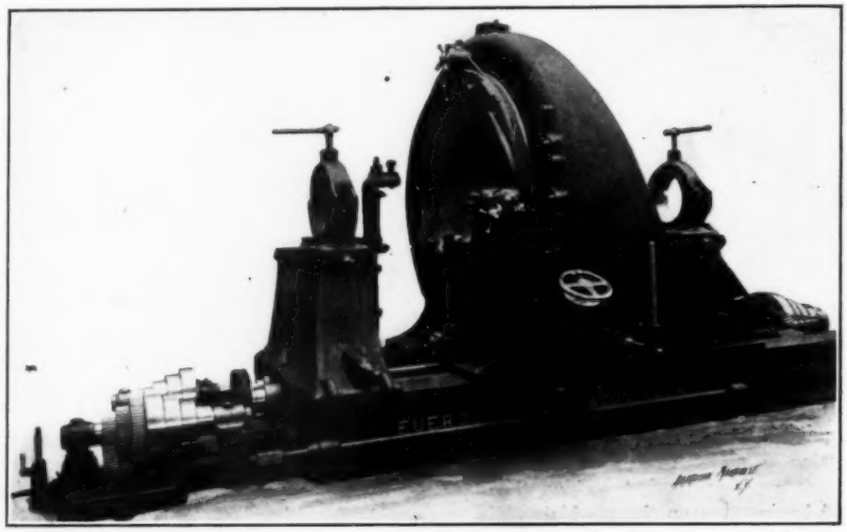
New Line of Motor Starters

The Electric Controller and Manufacturing Company, of Cleveland, O., has developed a new line of starters which are known as the "mill-type" design. These are made in panels, have supporting feet, and are completely self-contained. The dimensions of the different forms vary only in hight. The starters are furnished in several forms, beginning with a very simple form and elaborated on to embrace such features as no voltage release, overload protection for running, and separate and different overload protection for accelerating, the last named feature allowing more current to flow through the motor during starting than when running. If a motor be connected to a load having large inertia—such as a hot saw or a press with a heavy flywheel—the mere accelerating of the load demands a very considerable expenditure of work. Since this starting is relatively infrequent, the motor will not be injured by employing a starting current in excess of the running current, yet the starting time will be materially reduced. There are, in fact, numerous instances where it is desirable to allow an accelerating current larger than the running current.

In these starters, the usual dangers of a broken or weakened arm spring is absent, because no such spring is used. The no-voltage protection is secured entirely by a magnetic switch which opens upon failure of voltage and this, in connection with an overload coil, is used for securing overload protection. The magnetic switch can be closed only by bringing the arm to the "off" position, preventing injurious overloads to the motor upon the return of voltage after voltage failure. It can be held closed to the arm on any accelerating step only by holding in a push button. This prevents leaving any of the starting resistance permanently in circuit, and thereby burning out this resistance, and it will maintain itself closed only when the arm is at the full "on" position.

German Crankpin Turning Machine

The illustration shows a large German crankpin turning machine, built by the firm of Dreuer, Schumacher & Co., at



GERMAN CRANKPIN TURNING LATHE

Kalk, Germany, and capable of handling crankshafts up to about 18 inches in diameter. As will be seen, the crankshaft remains stationary, being held in position by the clamping rest at each end of the machine, the turning being done by the revolving tool-holder inside the massive head in the center of the machine. A large opening through the turning head allows the shaft to be threaded through and into the clamping bearings shown.

These bearings can be adjusted back and forth to accommodate the varying throws of the crankshaft, and after being adjusted so as to bring the crankpin central inside the turning head, the sides or cheeks of the crank are clamped by the support shown. This machine will not only turn the crankpin bearing itself, but also face up the inside of the crank cheek by means of the traversing head shown at the front of the revolving tool head. Star feeds are provided as shown, and the four spring controlled feed pins allow four rates of feed to be used. The whole tool head is fed along the bed by the large worm-driven screw beneath it and all required changes of speeds and feeds seem to be provided for. The feed is controlled by the hand-wheel in front of the tool head, so that the operator can always be in a position to see just what cutting is being done, and at the same time have complete control in his hands.

Handling Steel Rails by Lifting Magnets

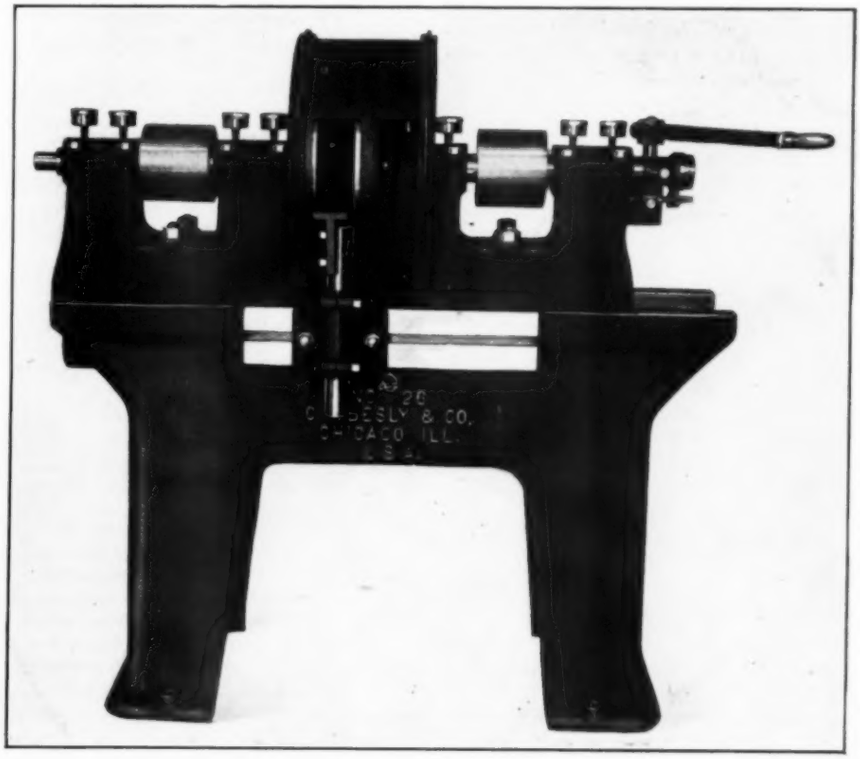
The illustration shows a very interesting application of the lifting magnets made

MAGNETS HANDLING RAILS FROM 10 TO 12 TONS

by the Electric Controller and Manufacturing Company, Cleveland, Ohio, in the handling of 33-foot steel rails at the mill of the Indiana Steel Company, Gary, Ind. By arranging the rails as shown a much larger number can be handled by a magnet of given width, and in this case the lifts average from 10 to 12 tons each. By using magnets in pairs in this way the crane operator has excellent control over the load. It is needless to say that this method saves considerable time in handling, and also requires very much less timber for spacing material when loading on cars. It also does away with the liability of bending the rails when loaded by magnet in the usual way. This interlocking of the rails, however, requires very carefully designed magnets owing to the fact that the top layer of rails practically short-circuits the magnetic circuit. The magnets shown have successfully lifted locked sections of 60-foot rails up to an aggregate load of 15 tons.

Double Spiral Disk Grinder

The illustration shows the latest addition to the line of grinders built by C. H. Besly & Co., Chicago, Ill. This carries two 18-inch disks guarded by the hood shown, and having one adjustable head giving a maximum opening between disks of 10½ inches. The work rest is adjustable along the front of the machine and also for hight. The bearing bushings are made in halves for adjustment, and the



NEW SPECIAL DISK GRINDER

end thrust is taken by hardened and ground steel collars of large dimensions. The wheel guard is telescoped to adjust itself for different widths of work being ground. The top is hinged so as to give instant access to the disks, and there is an opening below the wheels for connecting to an exhaust fan.

Provision has been made so that a third wheel and the usual rocker shaft can be added to the left-hand end of the machine at any time, and either the geared lever-feed table, swinging or tilting table can be used in connection with this wheel. Seven work rests are furnished with this machine, varying in width from 7/16 to 27/16 inches. The operating floor space required is 5x10 feet, and the speed of the grinding disk 1650 revolutions per minute.

A Difficulty with Thin Slitting Saws

By A. Kirkland

Anyone who has used thin metal saws will have experienced some difficulty in getting straight slots when using saws under 22 gage. The job was hosiery-machine cylinders which required from 180 to 220 slots 0.018 inch wide by ½ inch deep to be cut in cylinders of 4 inches in diameter. The old way was to find a saw which would cut straight by the cut-and-try method, which took a good deal of time. On examining the saws which gave trouble, they were found to be hollow on one side. I mounted one on an arbor, which I fixed on the cutter grinder, and set the wheel on an angle of about 15 degrees, and as near the arbor as pos-

sible. The saw was then brought onto the wheel and the arbor allowed to turn by the action of the wheel. The friction caused enough heat to expand the hollow side of the saw. On taking it out I found it to be quite flat and a trial proved it to be a success. After this a boy could put a saw right in about two minutes. They were of the Brown & Sharpe screw-slotting type.

Steam Hammers

While it is impossible to accurately rate the capacity of steam hammers with respect to the size of work they should handle, on account of the greatly varying conditions, a few notes from the experience of the Bement Works of the Niles-Bement-Pond Company will be of service.

For making an occasional forging of a given size, a smaller hammer may be used than if we are manufacturing this same piece in large quantities. If we have a 6-inch piece to forge, such as a pinion or a short shaft, a hammer of about 1100 pounds capacity would answer very nicely. But should the general work be as large as this, it would be very much better to use a 1500-pound hammer. If, on the other hand, we wish to forge 6-inch axles economically, it would be necessary to use a 7000- or 8000-pound hammer. The following table will be found convenient for reference for the proper size of hammer to be used on different classes of general blacksmith work, although it will be understood that it is necessary to modify these to suit conditions, as has already been indicated.

Diameter of Stock.	Size of Hammer.
3½ inches	250 to 350 pounds
4 inches	350 to 600 pounds
4½ inches	600 to 800 pounds
5 inches	800 to 1000 pounds
6 inches	1100 to 1500 pounds

Steam hammers are usually operated at pressures varying from 75 to 100 pounds of steam per square inch, and may also be operated by compressed air at about the same pressures. It is cheaper, however, in the case of compressed air to use pressures from 60 to 80 pounds instead of going higher.

In figuring on the boiler capacity for steam hammers, there are several things to be considered, and it depends upon the number of hammers in use and the service required. It will vary from one boiler horsepower for each 100 pounds of falling weight up to three horsepower for the same weight, according to the service expected. In a shop where a number of steam hammers are being used, it is usually safe to count on the lower boiler capacity given, as it is practically safe to say that all of the hammers are never in use at the same time. In a shop with a single hammer, on the other hand, and especially where hard service is expected, it is necessary to allow the larger boiler capacity as there is no reserve to be drawn on, due to part of the hammers being idle, as in the other case.

Steam hammers are always rated by the weight of the ram, and the attached parts, which include the piston and rod, nothing being added on account of the steam pressure behind the piston. This makes it a little difficult to compare them with plain drop or tilting hammers, which are also rated in the same way.

Business Items

The plant of the Steel Foundry Company, Cincinnati, O., William B. Melish, receiver, is for sale.

William L. Rickard has entered into partnership with Ray D. Lillibridge, technical publicity, 100 Broadway, New York City.

The Clark Foundry Company, Rumford, Maine, has been organized and has acquired the foundry and machine shops of the Record Foundry and Machine Company and the Jarrell Machine Company of the same city and they will build the Jarrell punch and shear. The officers of the company are P. B. Clark, president and manager, and O. A. Pettingill, treasurer.

Business Opportunities

The Muskegon (Mich.) Boiler Works will erect an addition.

J. Roeder will erect a $30,000 brewery at Monroe, Mich.

Pierce Engine Company, Racine, Wis., is erecting a machine shop.

The Utility Motor Car Company, Ludington, Mich., will erect a factory.

The Badger Motor Car Company, Columbus, Wis., will erect a new plant.

The Sivyer Steel Casting Company, Milwaukee, Wis., is to erect a new plant.

The Citizens Brewing Company, Antigo, Wis., is building a bottling works.

The Racine (Wis.) Steel Casting Company will erect a new factory building.

The Patten Paper Company, Appleton, Wis., will erect an addition to the plant.

The Columbia Can Company, St. Louis, Mo., will build an addition to their plant.

The Northwestern Packing Pad Company will erect a factory at Rice Lake, Wis.

The Grand Rapids (Mich.) Show Case Company will erect a three-story addition.

Bryan Bros., Perry, Iowa, are erecting a factory for the manufacture of cement products.

The Carondelet (Mo.) Auto and Machine Company is erecting a new factory building.

The Clare (Mich.) Knitting Mills will move to Saginaw, where a new plant will be erected.

Plans are being considered for a large addition to the Elston Worsted Mill, at Olneyville, R. I.

The Universal Crusher Company, Cedar Rapids, Iowa, has had plans completed for a new factory.

H. J. Miller & Co., 54 Gordon street, Glasgow, Scotland, are inquiring for can-making machinery.

The Ahnapee Veneer and Seating Company, Algoma, Wis., is building an addition to the plant.

The Corning & Painted Post Street Railroad, Corning, N. Y., will build a one-story repair shop.

The Pacific Iron Works, Bridgeport, Conn., will build an addition to plant; also new boiler house

The Scottdale (Penn.) Foundry and Machine Company will engage in the manufacture of gas engines.

The W. K. Henderson Iron Works and Supply Company, Shreveport, La., will erect a new foundry.

The Interstate Automobile Company, Muncie, Ind., will erect a duplicate of the present factory building.

A. W. McFarland, of Portland, Ind., will establish an egg case and box factory in Nashville, Tenn.

The Wolf River Chair Company, New London, Wis., will make some changes in engine room equipment.

The Narragansett Electric Lighting Company, Providence, R. I., will erect an addition to the boiler house.

Catalogs of agricultural machinery are desired by Joseph Serracarbo, 1707 Guilford avenue, Baltimore, Md.

Gray & Davis, Amesbury, Mass., manufacturers of carriage lamps, will build an addition to their factory.

The Citizens Club, of Sparta, Wis., is promoting the erection of a motor factory. The equipment is to cost $10,000.

The Everett-Metzger-Flanders Company, Detroit, Mich., will build a $4000 addition to their automobile factory.

Erection of a new plant for Hanbury & Flinn, 116-136 Fifty-seventh street, Brooklyn, N. Y., is about completed.

The Detroit River Iron Works, Detroit, Mich., has let a contract for the erection of a two-story factory building.

The Lombard Machine Company, Worcester, Mass., manufacturers of looms, will erect a two-story addition to plant.

The Weston-Mott Company, Flint, Mich., is to erect a new factory for the manufacture of automobile rims and hubs.

The Lewes Knitting Company, Janesville, Wis., will be in the market for some motors for a new building now being erected.

The Mills Electrical Company, Connellsville, Penn., is equipping a shop for the manufacture of electrical mining machinery.

The plant of the A. Walrath Company, Fort Plain, N. Y., making broom machinery, was destroyed by fire. Loss, $25,000.

The D. M. Sechler Carriage Company, Moline, Ill., is erecting an addition to be used for the manufacture of manure spreaders.

The Liberty Manufacturing Company, Pittsburg, Penn., manufacturing steam specialties, will build a $15,000 addition to plant.

The McCord Manufacturing Company, Detroit, Mich., making automobile parts, has taken out a permit to build a three-story factory.

Plans for a new roundhouse and repair shops for the International & Great Northern Railroad at Taylor, Texas, have been completed.

Agencia General de Agricultura, 2a Calle de las Damas 6, Mexico City, would like catalogs of agricultural machinery and implements.

The Union Drawn Steel Company, Beaver Falls, Penn., is making additions to its plant, including a new boiler house and machine shop.

The woodworking plant of the Peterman Manufacturing Company, Tacoma, Wash., was destroyed by fire, causing a loss of about $80,000.

Faust & Kammann, importers, Ronda Universidad 16, Barcelona, Spain, would like catalogs of machine tools, pumps, gasolene motors, etc.

The Hudson Motor Car Company, Detroit, Mich., will install a number of light tools for general repair and assembly work in the near future

The Southside Improvement Association, Richmond, Ind., is negotiating with an Ohio concern making automatic drills, to locate in Richmond.

The Reinforced Concrete Pipe Company, of Jackson, Mich., has acquired a site in Detroit,

to which place it will move on completion of the new plant.

The Ayer Mills, Shawmut building, Boston, Mass., is in the market for machine tools and woodworking machinery for repair shops at mills now being erected in Lawrence.

The American Automatic Railway Switch Company, Birmingham, Ala., capitalized at $500,000, will erect a factory for the manufacture of an automatic street car switch.

The Everett-Metzger-Flanders Company, Detroit, Mich., has purchased the plant of the De Luxe Motor Car Company. They will sell some of the old tools and install new ones.

Brownwood (Tex.) Gas and Eelectric Company will rebuild light and power plant recently burned. They will install machinery in gas plant to manufacture gas for fuel and lighting.

The American Seating Company, Grand Rapids, Mich., will erect an addition to be used as a steel plant, as pressed steel instead of cast iron for opera chairs and school desks will be used.

The Isthmian Canal Commission, Washington, D. C., will receive bids up to 10:30 a.m., August 16, for steel castings, reheaters for compressed air, die blanks, fire brick, etc., as per Circular No. 525.

The Howlet Manufacturing Company, Montgomery, Ala., will move to Cleveland, where a new plant will be erected. The company manufactures gas stoves and revolving self-heating sad irons.

M. B. John, Ballarat Brass Foundry, Lydiard street, Ballarat, Victoria, Australia, would like catalogs, quotations, etc., of equipment for manufacturing steam and water valves, cocks and general brassware.

The Davis Manufacturing Company, Milwaukee, Wis., is erecting an addition to its plant. The company manufactures automobile and marine engines, tubular micrometer calipers, steel bins and shelving.

The Frontier Iron Works, Buffalo, N. Y., is erecting a machine shop building which is the last of group comprising new plant. The company manufactures cylinders for automobile and marine gasolene engines.

The Demot Car Company, Detroit, Mich., has been incorporated and taken over the old plant of the Carter Car Company. The company will install light tools for assembly work. Chas. Hohmeier, superintendent.

The Willard Machine Tool Company, Cincinnati, Ohio, has secured site for a new plant at Covington. The company which now makes power presses, dies and special machinery, will add engine lathes to its product.

The Luce Manufacturing Company, Dalton, Mass., capitalized at $20,000, is in the market for machine tools, including engine lathe, bench lathe, turret lathe, drill press, universal milling machine. T. C. Luce is president.

The Isthmian Canal Commission, Washington, D. C., will receive bids up to 10:30 a.m., August 2, for car wheels and axles, steel, iron, rivets, bolts, steel cable, pipe fittings, valves, steam whistles, gages, hand oil-pumps, cocks, force cups, push carts, platform scales, tool grinders, hydraulic punches, carborundum wheels, pulleys files, saws, pliers, twist drills files, etc., as per Circular No. 523.

The Navy Department, Bureau of Supplies and Accounts, Washington, D. C., will open the following bids: August 3—Bolts and nuts, gas pliers, shovels, rasps (schedule 1460), brass chain, spring steel cotters, oil cups, steel rivets, steel wire (schedule 1462), crucibles (schedule 1465), carbon tool steel (schedule 1463): August 10—Leather belting, iron pipe sets, steel wheelbarrows (schedule 1444), thermometers (schedule 1445), sheet brass, bronze, solder, plate steel (schedule 1445).

New Incorporations

The McKinnon Chain Company, Buffalo, N. Y., has been incorporated. Capital, $1,000,000. Directors, L. E. McKinnon, W. A. Notman, R. L. Notman.

Henderson Iron Works, Jersey City, N. J., incorporated to conduct iron and steel works. Capital, $50,000. Incorporators, J. Henderson, A. Henderson.

The Highway Metal Culvert Company, Kittery, Me., has been incorporated to manufacture metal road culverts. Capital, $10,000. H. Mitchell, Kittery, president.

The Empire Jewelry Manufacturing Company, Newark, N. J., has been incorporated. Capital, $50,000. Incorporators, C. A. Hohnhold, J. Hoehing, U. C. Jones.

West Chicago Sash and Door Manufacturing Company, Chicago, Ill., has been incorporated. Capital, $40,000. Incorporators, W. F. Haase, E. W. Walsh, W. H. Opie.

The National Electric Welding Company, Hoboken, N. J., has been incorporated to do electric welding. Capital, $150,000. Incorporators, Wm. Moeller, M. Smith, F. Bueckel.

The Universal Auto Company, East Orange, N. J., has been incorporated to manufacture automobiles, cabs, trucks, etc. Capital, $50,000. Incorporators, P. Osborne, H. B. Ludlum, W. H. Brearley.

The Price Talking Machine Company, Newark, N. J., has been incorporated to manufacture phonographs, musical instruments, etc. Capital, $25,000. Incorporators, H. S. Price, M. G. Price, H. H. Wilcox.

U. S. Ball Bearing Manufacturing Company, 112 Clark street, Chicago, Ill., incorporated to manufacture ball-bearing devices. Capital, $50,000. Incorporators, F. Henzelman, Carl Rathert, J. W. Utesch.

The Venn Manufacturing Company, Chicago, Ill., has been incorporated to manufacture and deal in machinery, specialties and novelties. Capital, $10,000. Incorporators, T. H. Venn, O. C. Dennis, H. J. Keating.

The Kaestner & Hecht Company, Chicago, Ill., has been incorporated for the purpose of manufacturing machinery of all kinds. Capital, $150,000. Incorporators, E. F. Hecht, F. E. Matthews, C. W. Rhodes.

The Niagara and Erie Power Company, Buffalo, N. Y., has been incorporated to furnish electricity for light, heat and power. Capital, $100,000. Directors, C. F. Blair, M. J. Binkley, A. F. Tideswell, all of Buffalo.

The Globe Air Lift Pump Company, of New York City, has been formed to manufacture air lift pumps, motors and engines. Capital, $500,000. Directors, J. A. Rose, William Whelpley, of New York, and others.

Saurer Motor Trucks, West Orange, N. J., has been incorporated to manufacture motors, engines, machinery, etc. Capital, $200,000. Incorporators, W. D. Sargent, West Orange; G. M. Judd, E. H. Fallows, New York.

The Garlock Auto Specialty Company, Palmyra, N. Y., has been incorporated to manufacture air-purifying devices for automobiles, etc.; also to manufacture engines and automobiles. Capital, $10,000. Incorporators, O. J. Garlock, H. E. Whiting, S. D. Van Alstine.

New Catalogs

Rockwell Furnace Company, 26 Cortlandt street, New York. Book showing product. 8x11 inches, paper.

Morse Chain Company, Ithaca, N. Y. Machine Tool Bulletin No. 8, showing application of silent chain. 34 pages, 6x9 inches.

The Glidden Varnish Company, Cleveland, Ohio. Booklet describing acid proof coating for iron and steel. 3½x6 inches.

The Graton & Knight Manufacturing Company, Worcester, Mass. Booklet on Spartan belting. Illustrated, 16 pages, 3½x6 inches.

Lea Equipment Company, 90 West street, New York. Bulletin H, describing Lea high-duty turbine pump. Illustrated, 8 pages, 6x9 inches.

General Electric Company, Schenectady, N. Y. Bulletin No. 4672, illustrating electric drive for large printing presses. Bulletin No. 4674, describing polyphase induction motors. Bulletin No. 4679, describing Type D.LC commutating pole motor.

American Blower Company, Detroit, Mich. Booklet No. 253, which is handbook of information on blowers and exhausters for glass factories. Illustrated, 20 pages, 3½x6 inches. Booklet No. 257, entitled "Ventilating and Cooling." Illustrated, 3½x6 inches. Booklet No. 258, describing Sirocco fan. Illustrated, 3½x6 inches.

Acheson Oildag Company, Niagara Falls, N. Y. Pamphlet containing reports of Prof. Charles F. Mabery and the Committee of the Automobile Club of America on merits of Oildag as a lubricant. Illustrated, 18 pages, 5½x8 inches. Booklet entitled, "Oildag Increases the Available Power of a Gas Engine and Makes It Run Like Velvet." Illustrated, 12 pages, 3½x6 inches.

Want Advertisements

Rate 25 cents per line for each insertion. About six words make a line. No advertisements abbreviated. Copy should be sent to reach us not later than Friday for ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded, they will be destroyed without notice. No information given by us regarding any advertiser using box number. Original letters of recommendation or other papers of value should not be inclosed to unknown correspondents. Only bona-fide advertisements inserted under this heading. No advertising accepted from any agency, association or individual charging a fee for "registration," or a commission on wages of successful applicants for situations.

Miscellaneous Wants

Caliper list free. E. G. Smith, Columbia, Pa.

We buy or pay royalty for good patented machine or tool. Box 282, AMER. MACH.

Hand power bending tools, labor-saving, money-making. Estep & Dolan, Sandwich, Ill.

Light, fine machinery to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

Machines designed; automatic special. Practical working drawings. C. W. Pitman, 3519 Frankford Ave., Philadelphia, Pa.

Special machinery accurately built. Screw machine or turret lathe work solicited. Robert J. Emory & Co., Newark, N. J.

Light and medium weight machinery and duplicate parts built to order; tools, jigs, etc. MacCordy Mfg. Co., Amsterdam, N. Y.

New foolproof crude oil engine, Diesel type, no compressor. Inventor would like to negotiate with firms of standing. Box 452, AM. MA.

Metal specialties manufactured; models, dies and special machinery. Inventions perfected; correspondence solicited. W. E. Villinger, Williamsport, Pa.

Am in market for a machine for coiling copper pipe of various sizes, say five-inch coil of three-quarter inch pipe, number eighteen gage. James W. See, Hamilton, Ohio.

I have an unusually good proposition. Wish to connect with firm desiring additional line of manufacture. Would consider organization of new company. Box 387, AM. MA.

Wanted—To sell or negotiate machine patents, patterns, etc.; big market and good profit; highest possible indorsements; $10,000 to $25,000 backing required. "Builder," 808 N. C Ave., Washington, D. C.

A large English firm of machine-tool importers having showrooms and offices in Great Britain, France, Italy and Japan, is wanting good agencies for machine tools of all kinds. Apply Box 189, AMERICAN MACHINIST.

Wanted—Machinery to build (special line for Canada) or would build on royalty, or would consider manufacturing proposition. Have general machine shop equipment and exceptionally low costs. Box 424, AMERICAN MACHINIST.

A large well equipped machine shop on the south side of Chicago would like some work outside of its regular line; factory is equipped to do small and moderately heavy work; also experimental work; has good railroad facilities. Box 428, AMER. MACHINIST.

To correspond with machining contractors having ample capacity and desiring contracts for machining automobile cylinders and pistons in lots 50 to 1000. Either New England or near New York City. "Automobile," Box 451, care AMERICAN MACHINIST.

Situations Wanted

Classification indicates present address of advertiser, nothing else.

CONNECTICUT

Superintendent, good executive, experienced in rapid production of electric and plunger elevators, desires change. Box 459, AM. MA.

ILLINOIS

Wanted—Position as superintendent by a man experienced in modern machine shop and foundry practice; a good organizer and executive who can increase output and reduce costs. Address Box 435, AMER. MACH.

NEW JERSEY

German toolmaker and machinist, 35 years of age, 18 years' experience building automatic machinery, tools, jigs, also die work, wants steady position in New York or vicinity. Box 460, AMERICAN MACHINIST.

NEW YORK

Mechanical designer is open for responsible position; nine years' experience; employed, but desires change. Box 461, AMER. MACH.

Wanted—Position as superintendent or general foreman by man of broad experience, both light and heavy work. Expert mechanic and cost reducer; thoroughly familiar with piece price and premium systems. References furnished. Thirty-five years old. Box 453, AMER. MACH.

OHIO

Mechanical engineer, college graduate is open for superintendency of small or medium size shop, that will grow under good management; salary to start less object; hydraulic, steam, pneumatic and electric machinery. Box 440, AMERICAN MACH NIST.

PENNSYLVANIA

Assistant superintendent or toolroom foreman will be open for position tool and die work. expert machinist; executive ability; 18 years experience; best reference. Box 448, AM. MA.

Help Wanted

Classification indicates present address of advertiser, nothing else.

CANADA

Wanted—First-class toolmakers and machinists, accustomed to automobile, jig and fixture work. Apply Reo Motor Car Co. of Canada, Ltd., St. Catharines, Ont.

CONNECTICUT

Wanted—Man to operate B. & S. automatic screw machines. Address P. O. Box 43, Station A. Hartford, Conn.

ILLINOIS

Wanted—First-class vise and floor hands; only those accustomed to machine tool work need apply. Write the Ingersoll Milling Machine Co., Rockford, Ill.

Wanted—A young man who is a first-class machinist with a good education, to learn to operate our machines on the road for us, and eventually to work into the position of salesman. Apply, giving full history of experience, stating age and details in full. The Ingersoll Milling Machine Co., Rockford, Illinois.

INDIANA

Two experienced foremen for machine and assembling rooms, manufacturing gasolene motors. Give reference, experience and age. Box 262, AMERICAN MACHINIST.

IOWA

Wanted—An instructor in descriptive geometry and drawing, preferably a graduate in mechanical engineering. Salary, $1000 for nine months work. Address, giving qualifications, references and sample of drawing, William G. Raymond, State University of Iowa, Iowa City, Iowa.

MAINE

Draftsman, with experience as detailer on automatic machinery, to work on special machinery for paper products; 10 hours; good pay. Address, stating experience, Box 456, AMERICAN MACHINIST.

MASSACHUSETTS

Wanted—Machinist experienced as toolmaker and foreman. Address, stating age, experience and pay required. Box 419, AM. MACH.

Wanted—Experienced time study man, one with mechanical training preferred. This is a steady job with good chances for the right man. Apply to Post Office Box 5285, Boston, Mass.

Wanted—General superintendent. Must be an exceptionally capable and experienced man with successful record, having large mechanical and executive ability. Permanent position in factory, employing 2500 hands. Box 446, AMERICAN MACHINIST.

MICHIGAN

Wanted—A few first-class toolmakers on small work; good wages and steady employment for competent men. Box 278, AM. MA.

First-class toolmakers, machinists, turret lathe hands, milling machine hands, wanted; some capable of taking charge of departments. Must be A-1 men. Give age, experience, wages, etc. Apply Buick Motor Co., Flint, Michigan.

Wanted—Large automobile manufacturing concern bringing out new model, wants services of several competent tool and jig designers; permanent positions for right men. Give experience, date available and salary expected in replying. Address Box 454, AMER. MACH.

MISSOURI

Wanted—Inspector on close accurate machine work for a large electrical concern in the West. Box 430, AMERICAN MACHINIST.

Wanted—First-class tool designer experienced on adding machine work. Address Adding Typewriter Company, Poplar Bluff, Mo.

NEW YORK

Lathe, planer and boring mill hands wanted for night and day shift; no labor troubles; increasing force; applicants must state wages desired, past experience and if employed at present to receive further consideration. Apply, Ingersoll-Rand Co., Painted Post, N. Y.

1000 Island Boat & Engine Co., Morristown, N. Y., wants good, steady general machinist. Steady work at good wages for this section is offered. Preference will be given to those that will put in a small amount of capital. We have a fine location and growing business.

OHIO

Wanted—Die makers. 201 Nicholas Building, Toledo, O.

Wanted—First-class toolmakers, machinists and patternmakers. Address Box 116, Cleveland, Ohio.

Wanted—First-class engineer, experienced in air and vacuum work. Give full particulars education, experience, age, salary. Address Box 445, AMERICAN MACHINIST.

Wanted—Machinists; only good men need apply. Crank, lathe planer, boring mill and bars, radial drill, Jones & Lamson screw machine, toolmakers, floor and vise handles, increasing force; steady work; good wages. Box 457, AMERICAN MACHINIST.

Wanted—Works manager, capable of taking entire charge of plant employing 300 men manufacturing special machinery. Must be thoroughly experienced in drafting-room, foundry, pattern and machine shop practise. Give full details of self and experience. Box 442, AMER. MA.

Men wanted for automobile factory in northwestern Ohio. Applications wanted for future openings. Machinists, assemblers, toolmakers, molders, machine, bench and floor, millwright helpers, testers, punch press hands, painters, upholsterers. Answering by letter please state rate per hour wanted. Address Box 458, AMERICAN MACHINIST.

PENNSYLVANIA

Machinists wanted. Lathe, boring mill and floor hands, air compressor work. The Blaisdell Machinery Co., Bradford, Pa.

Wanted—Draftsmen with experience in designing and checking machinery and machine tools. Location, eastern Pennsylvania. Box 447, AMERICAN MACHINIST.

Wanted—An experienced man as foreman of a machine shop employing about ninety men; must have occupied similar position. Applicant will state age, experience and give references. Box 434, AMERICAN MACHINIST.

Wanted—Several tool draftsmen on tools, jigs and fixtures for small interchangeable work. Only A-1 men, neat, rapid and accurate, need apply. Also a man to check drawings of the above description. In answering, please state age, experience and wages expected. Box 449, AMERICAN MACHINIST.

Wanted—A good live agent in every shop or factory in the U. S. to sell one of the best known preparations for removing grease and grime from the hands without injury to the skin. Absolutely guaranteed. An agent can make from $5.00 to $25.00 over and above his regular salary. This is no fake. Write for free sample and agents' terms. The Klenzola Co., Erie, Pa.

RHODE ISLAND

Wanted—Experienced grinding wheel salesman to travel in New England, New York and New Jersey. In reply state age, experience, salary expected and references. Box 450, AMERICAN MACHINIST.

WASHINGTON

Wanted—Foreman toolmaker. A factory employing 200 workmen, equipped with modern tools, manufacturing a line of solid gold jewelry, sterling silver tableware, souvenir badges and novelties, requires a first-class toolmaker with executive ability to take charge of the toolmaking department. A man not over 40, thoroughly conversant with modern methods of manufacturing. References will be required. Box 443, AMERICAN MACHINIST.

WEST VIRGINIA

Wanted—Some first-class mechanics for lathes, planers and assemblers; best wages paid for best men. None but really first-class mechanics need apply. Address Box 158, Wheeling, W. Va.

WISCONSIN

Reliable machinists who desire steady employment in an automobile factory located in a cool, healthful, small city are advised to call, ready for work, at any time within four months, at the Rambler factory, Kenosha, Wis.

The advertiser needs a man qualified to select and engage skilful machinists and other employees for an automobile factory. The right man can have good remuneration, and if desired, a responsible permanent position. Address "Automobile," AMER. MACHINIST.

An exceptional opportunity is offered a man thoroughly experienced in the design and manufacture of electric wiring devices. Must be a practical mechanic, with the ability to produce new devices to meet the requirements of the trade, and must also have ability and experience to superintend their manufacture. Address Box 455, care of AMERICAN MACHINIST, New York, stating age, experience, salary expected and when available. All communications will be considered strictly confidential.

Alphabetical Index to Advertisers

	PAGE
Acme Machinery Co.	119
Adams Co.	122
Advance Machinery Co.	105
Almond Mfg. Co., T. R.	110
American Emery Wheel Wks.	109
American Gas Furnace Co.	112
American Pulley Co.	101
American School of Correspondence	105
American Swiss File and Tool Co.	3d cover
American Tinol Co.	116
American Tool and Mach. Co.	119
American Tool Works Co.	8
American Tube and Stamping Co.	127
American Wood Working Machinery Co.	98
Armstrong-Blum Mfg. Co.	111
Armstrong Bros. Tool Co.	124
Automatic Machine Co.	116
Baker Bros.	90
Barnes Co., Wallace	98
Barnes Co., W. F. & John	14
Barnett Co., G. & H.	50
Bath Grinder Co.	85
Baush Machine Tool Co.	25
Bay State Stamping Co.	98
Beaman & Smith Co.	15 and 110
Becker Milling Machine Co.	23
Bemis & Call Hardware and Tool Co.	104
Besly & Co., Chas. H.	124
Bethlehem Foundry and Machine Co.	115
Bignall & Keeler Mfg. Co.	108
Bilgram Machine Wks.	107
Billings & Spencer Co.	98
Blaisdell Machinery Co.	105
Blanchard Machine Co.	117
Bliss Co., E. W.	31
Blount Co., J. G.	109
Boker & Co., Hermann	1 and 83
Boston Gear Works	106
Bradford Machine Tool Co.	5
Bristol Co.	4th cover
Brown & Co., R. H.	110
Brown & Sharpe Mfg. Co.,	92, 93 and 4th cover
Browning & Co., Victor R.	100
Brubaker & Bros., W. L.	116